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MAIN TRENDS IN TECHNICAL PROGRESS IN THE USSR, 1959-1965

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INTRODUCTION

Rapid development of the national economy along the path of communism and the maximum lead in the world economic struggle between socialism and capitalism are the fundamental tasks of the forthcoming Seven Year Plan.

The continuous growth of socialist production is based on superior technology accompanied by constant technical progress, which is the basis of a reduction in production costs and is the most important prerequisite for growth of labor productivity and a rise in the material and cultural level of the life of the Soviet people.

Our country already surpassed those technical achievements which still occupy the contemporary capitalist society and, through its technical progress, is confidently leaving behind the capitalist countries in the field of technology.

Over a very short period of time, the Soviet people have built a highly developed Socialist industry. Every branch of the national economy was transformed and raised to new heights on the basis of this industry, and socialist society has grown and become stronger.

The Soviet Union changed beyond recognition in the 42 years since the Socialist Government was established. About two ten year periods were taken up with the Civil War and the Second World War, and then followed periods of building of the national economy which was demolished.

Today the USSR is a powerful, industrial state with advanced technology and a large army of engineers and technicians. This unprecedented leap from a primitive technology to a first rate machine industry demonstrated the whole world the supreme advantage of a socialist system of guiding an economy.

Electrical energy is progressively penetrating every branch of our production. The Soviet people are becoming more and more proficient in the fields of high velocity, pressure, and temperature, and have introduced automation, telemechanics, radio technology, electronics, and other new technical achievements into the production processes.

Mechanization and automation of production processes is widely practical. Machines which are operated mathematically are used in the chemical industry, in metallurgy, and in other branches of the national economy. Intensification of the different technological processes is being carried out, and new machine designs, new means of transportation, and new technological systems utilizing the latest advances in technology are being created.

As stipulated by the Seven Year Plan, the widescale introduction of automation in the productive processes, including a shift to automated technological processes and shops and to fully automated enterprises, in the last analysis will lead to reconstruction

of industry on a new technical basis.

During the balance of the current seven Year Plan, there will be a rapid growth in the branches of heavy industry; electrical energy production, smelting of cast iron and steel, and extraction of coal and oil, gas and peat, will all expand, along with great development in the chemical industry, in machine building, and other branches of our national economy.

The creation of a material-technical base for communism, a further strengthening of the economic and defensive power of our Motherland, and at the same time complete fulfillment of the growing material and spiritual needs of the Soviet people are the main tasks during this period. This will be a decisive stage in our competition with the capitalist world, when the historic task of overtaking and surpassing the highly-developed capitalist countries in per capita production must be practically completed.

In a resolution of the 21st Congress of the CPSU, on a report by N. S. Khrushchev entitled O Kontrol'nykh Tsifrakh Razvitiya Narodnogo Khozyaystwa SSR na 1959-1965 (Scheduled Figures for Develompement of the National Economy of the USSR for 1959-1965), which stresses that "As a result of the fulfillment of the Seven Year Plan the Soviet Union will bring about a per capita industrial production which is greater than is presently being realized in the most highly developed capitalist countries of Europe, England and West German, and, on the basis of this, the Soviet Union will occupy the foremost position in Europe. In the absolute output of certain leading types of production the Soviet Union will surpass the present production level of the United States of America and in other areas it will come close to that level. The production of the most important agricultural products, as a whole and on a per capita basis, will by that time have surpassed the present level of the US. After this, five years will be needed to overtake and surpass the US in per capita industrial production. Thus, by the end of that period, and perhaps even sooner, the Soviet Union will occupy a leading position throughout the world both in the absolute production volume and in per capita production. This will constitute a world-wide, historic victory for socialism in its competition with capitalism."

The creation of a material-technical basis for communism will above all assure a highly developed industry, complete electrification of the country, technical progress in all branches of agriculture and industry, mechanization and automation of all industrial processes, and a full utilization of the new sources of energy, of rich natural resources, and of the new synthetic and other types of materials. It will also provide for a rise in the cultural-technical level of all workers, further improvement in the organization of industry, and an increase in labor productivity.

THE MAIN TRENDS IN TECHNICAL PROGRESS IN THE USSR

In all stages of socialist construction, the Communist Party of the Soviet Union has placed, and still places, great importance on the development of industry, especially heavy industry, which is the basis of the socialist economy, a source of power for our country, and a decisive factor in the development of industrial forces and in an increase in labor productivity in all branches of the national economy.

Since the first days after the Great October Socialist Revolution, the Communist Party and the Soviet Government have devoted their constant attention to technical progress - to the development of technology and its introduction into all branches of the national economy.

The Great Lenin taught that "He who has the greatest technology, organizational ability, discipline, and the best machines, gains the upper hand ... without machines and without discipline it is impossible to exist in contemporary society." [See Note].

[Note:] V. I. Lenin, Works, Vol 27, Page 167.)

After the Great October Socialist Revolution, the task of bringing the country out of retardation, of creating a powerful, economic base corresponding to the new, advanced social system - the socialist system, was established.

The main trends of the great technical progress which is taking place in the USSR are as follows: ELECTRIFICATION OF THE NATIONAL ECONOMY, MECHANIZATION AND AUTOMATION OF INDUSTRIAL PROCESSES, AN ACCELERATED DEVELOPMENT OF THE CHEMICAL INDUSTRY, AND AN INTENSIFICATION OF TECHNOLOGICAL PROCESSES. Work which was carried out in the USSR on the utilization of rocket and atomic technology has had great significance in terms of peaceful goals.

The Electrification of the Country.

V. I. Lenin indicated that "only after the country is electrified, when industry, agriculture, and transportation are supported by a technical base of modern large scale industry, only then will we be finally victorious." [See Note].

([Note:] V. I. Lenin, Works, Vol 31, page 484.)

Electric power has concrete advantages over other types of power. It is easier to transmit over long distances; it is highly divisible. Furthermore, electric power is cheaper than other types of energy, especially when it is generated by immense hydraulic or thermal power plants utilizing local low grade fuel (peat, low-caloric coal).

The use of electric power makes the automation of industrial processes highly possible, since it is possible to combine it with different types of electro-drive, relay (electro-magnetic, electronic, etc.), contactors, etc. Electric power also makes it possible to mechanize difficult, labor-consuming operations in the mining of coal by using coal cutters, coal combines, electric mining locomotives; to use electric excavators, and dredging apparatus in excavation work; and to transport construction materials with tower cranes and other types of cranes, conveyors, and elevators.

Also, important branches of technology are based on electric power, such as electronics, radio technology (radar and television), the atomic energy industry, etc.

It is for these reasons that electrification of the country is now one of the main trends in the technical progress of the USSR and is the most important requirement for this progress. CONTEMPORARY TECHNOLOGICAL PROGRESS IS IMPOSSIBLE WITHOUT THE USE OF ELECTRICAL ENERGY.

Mechanization and Automation of the Industrial Progesses.

Another important trend in the technical progress of our country is the mechanization and automation of industrial processes in industry and agriculture. In a report to the 21st Congress of CPSU, N. S. Khrushchev stated, "Successful completion of the tasks set forth by the Seven Year Plan is possible only if a new technology, FULL SCALE MECHANIZATION AND AUTOMATION of Industrial processe, and SPECIALIZATION AND COOPERATION are widely introduced into all branches of the national economy."

In June 1959 the Plenum of the Central Committee of the CPSU discussed measures required to fulfill the resolution of the 21st Congress of the CPSU concerning the introduction of mechanization into industry and construction, the automation of industry, use of production lines, replacement of outdated equipment, punchers and instruments in order to further expand industrial productivity and construction. These actions are also required to raise the quality of production and to lower its cost, along with the cost of construction work. Successful fulfillment of the tasks set forth by the June (1959) Plenum of the Central Committee of the CPSU will accelerate our progress along the path toward Communism.

A decision of the Plenum of the Central Committee of the CPSU of 29 June 1959 stated "The Communist Party considers mechanization and automation of the industrial processes to be the primary methods of achieving technical progress, without which a rapid tempo in the growth of labor productivity is impossible. Mechanization and automation have not only economic significance but also enormous social significance. In a socialist society, mechanization and automation of the industrial processes meet the urgent needs of the workers; facilitates the work, and in the long run will change the nature

of work, for millions of people; it increases labor productivity; makes it possible to shorten the work day, and to eliminate the existing differences between mental and physical labor."

Through automation man is not only freed from heavy physical labor, but even from such work as control and regulation of machines, which are either completely or partially handled by means of automatic devices which operate alone, without the help of a human being. Thus, man is left only with the work connected with starting, repairing and periodic checking of the automats.

One of the most sharply defined examples of automation of industrial processes is the creation of a factory-automat which manufactures alumium pistons for automobile engines. In this factory, all of the operations, beginning with smelting of the metal, manufacture of a casting, quality control, and final boxing of the product, are completely automatic.

In comparison with the usual organization and technology of production, the number of workers needed with a factory-automat is decreased 4.2 times; the number of mechanics and operators, 5.2 times. Labor consumption is decreased 5.3 times, and the duration of the production cycle is decreased twofold. All of the workers are highly skilled supervisors of the industrial process and are freed completely from heavy, physical work.

Consequently, the Communist Party is carrying out an extensive program for the mechanization and automation of the industrial processes, and for the introduction of remote control in industry. In our country the manufacture of machine-automats for metal working, automatic production lines, etc. is widely developed, and the automation of industrial processes in metallurgy, chemistry, machine construction, and other branches of industry is being carried out. The shift from automation of individual plant units and operations to the automation of entire plants, technological processes, and fully automated establishments is foreseen by plan figures for the development of the national economy in the USSR for 1959-1965.

Extensive perspectives in the automation of industry are provided by the achievements of the computer technology. The use of computing machines in directing industrial processes makes it possible to automatically select and carry out technological progress in the most efficient way.

Along with fulfillment a general program of automation in all branches of industry, plans are now being made to create more than 50 experimental-demonstration establishments, which will implement the newest ideas in full scale automation.

Rapid Development of the Chemical Industry.

An important trend of technical progress in our country is the rapid DEVELOPMENT OF THE CHEMICAL INDUSTRY, in which chemical methods are used to reprocess raw materials and materials in order

to obtain various valuable products which often cannot be obtained in any other way.

The creation of a chemical industry has made it possible to manufacture large amounts of synthetic rubber, which is equal in quality to natural rubber. The chemical industry has supplied the national economy with plastic materials, which are widely used not only in homes but also in industry, particularly as substitutes for non-ferrous metals, and has also produced various medical preparations, dyes, perfumes, etc.

Chemical methods have made it possible to utilize those types of raw materials which were formerly considered to be non-usable industrial by-products, for example, products resulting from the coking of coal, gases from the boiler equipment in thermal electric power plants and from blast furnaces, by-products from the manufacture of sulfuric acid, from sawmills and pulp mills, etc. The chemical industry supplies agriculture with fertilizers and also with chemical means to combat agricultural pests. It produces different types of artificial fibers, leather substitutes, dyes, etc.

The large-scale production of different types of synthetic materials makes it possible to increase the output of high quality and low cost goods for consumer consumption and also to raise the technical level and the economy of all branches of the national economy. The use of these materials in construction work, especially home building, and in the furniture industry opens up tremendous possibilities.

The Seven Year Plan stipulates a threefold increase in the output of mineral fertilizers and a considerable expansion in the variety of chemical production. There will be an increase in the production of concentrated mineral fertilizers, of the most effective phosphorous, organic preparations to combat pests and crop diseases, and also chemical agents to combat weeds.

Intensification of the Industrial Processes.

INTENSIFICATION OF THE INDUSTRIAL PROCESSES is also one of the main trends in the technical progress of the USSR. It has contributed toward a sharp increase in labor productivity, since it makes it possible to accelerate the technological process, to shorten the industrial cycle, and to make better use of equipment. For example, intensification of the blast furnace industry provides for better utilization of the effective area of the blast furnaces; rapid cutting is an important factor in the rise of labor productivity in metal working, and so on.

These main trends of technical progress, along with other technological developments, provide a material-technical base for communism.

Thus, the creation of a material-technical base for communism requires a further growth in science and technology, active participation on the part of teachers, engineers, and technicians in solving the problems which are connected with the further development of the industrial forces in our country.

During the current Seven Year Plan our teachers, engineers, technicians, and practicians will master controlled thermonuclear reactions in order to obtain an almost infinite source of energy. They will also strive for the extensive use of atomic energy for power engines and for engines used for transportation, for more effective utilization of synthetic materials, nuclear fission products, and radioactive isotopes. They will solve the problems of a full scale mechanization and automation of the industrial processes, and will discover new technical methods on the basis of a widespread application of physics, radio electronics, and computing technology.

ENERGETICS

Electric power is the basis for the development of contemporary technology.

Electricity is penetrating more and more into everyday life, into industry, and is contributing to the reorganization of many technological processes.

It is impossible to imagine contemporary technology without the use of large amounts of energy. For example, the telephone, telegraph, radio, television, movies, and so on could not exist without utilizing energy. In general, no branch of industry can do without energy apparatus of great power.

Energetics has steadily expanded and is rapidly developing. It is sufficient to state that now there is a new chapter to be added - utilization of atomic energy. The first steps have been taken along this path, but at the present time it is still difficult to foresee to what extent the use of atomic energy will change the form of energetics. It is only certain that the changes will be considerable, and that as a result mankind will become even more powerful than it is today.

The development of energetics has made it possible to bring about uniform electrification throughout the country. This has created a base for the development of productive capacity of our country, which in turn will be a basis for the successful building of a communist society.

Electrification of all branches of the national economy, which is something that which Lenin once dreamed about, is now a reality; year by year our people increase the construction of new electric power plants.

We obtain electric power from thermal, hydraulic, atomic, solar, wind, and other electric power plants.

<u>Heat Energetics.</u>

"The construction of thermal electric power plants using cheap coal, natural gas, and fuel oil, the rapid development of electrical systems, and the subsequent creation of a single energy system for the USSR which would assure a more rapid development of energetics at decreased capital expense and at a higher technical level" is foreseen as a main trend in the development of electric power in the USSR and is specified by scheduled figures for the development of the national economy for 1959-1965.

This trend in the development of energetics in our country makes it possible to invest more capital in heavy industry, especially in the chemical industry, and ferrous and non-ferrous metallurgy. In addition, the construction of thermal electric power plants makes it possible to gain time in the competition with capi-

talism, and to overtake and surpass the United States in per capita production more rapidly.

The installation of hydroelectric power plants requires a great outlay of labor, time, and capital. In this respect, thermal electric power plants are a great deal more efficient. The specific capital outlay for installation of thermal electric power plants is 3-4 times less than for hydroelectric power plants, and much less time is necessary to build them. The Volga Hydroelectric Power Plant imeni V. I. Lenina with a capacity of 2,300 thousand kilowatts, for example, took seven years to build. With the same amount of capital and in a shorter period of time it would be possible to build several thermal electric power plants with an overall capacity of 11 million kilowatts. A certain increase in the price of electric power from these plants is more than covered by the increasing labor productivity in all branches of the national economy on the basis of the expanded use of electricity.

At the present time large-scale thermal electric power plants have been constructed and are in operation - the MIRONOVSKAYA, SLAVYANSKAYA, YVZHNO URAL'SKAYA, CHEREPETSKAYA and many other thermal electric power plants. 81% of the overall electric power production in the USSR comes from thermal electric power plants.

Table 1

Generation of Electric Power by Thermal Electric Power Plants (in the USSR in billion kilowatt-hours.)

1956	1957	1958	1965
155.3	169.9	188.7	416

At the present time 30 powerful thermal electric power plants are under construction in the USSR. Among the large-scale installations are the ZMIYEVSKAYA GRES (Gosydarstvennaya Rayonnaya Elektrostantsiya - State Rayon Electric Power Plant) in the Khar'kovskaya Oblast, the CHERNIGOVSKAYA TETS (Teploelektrotsentral' - Heat and Electric Power Plant) at Chernigov, the PRIDNEPROVSKAYA GRES in the Dnepropetrovskaya Oblast, the DOBROTVORSKAYA GRES in the L'vovskaya Oblast, the STAROBESHCHEVSKAYA GRES in the Stalinskaya Oblast, and others. More than 60 thermal electric centers and state rayon electric power plants (GRES) are under renovation.

We have been very successful in developing new, advanced furnaces which have made it possible to use low-grade fuel, such as lignite and peat, which are very abundant in our Motherland. Thus, the consumption of conventional fuel for the generation of one kilowatt-hour has decreased yearly, as is indicated by the data in Table 2.

Table 2.

Consumption of Conventional Fuel in Grams Per One Generated Kilowatt-Hour.

1913	1928	1940	1957	1958	1965
1,060	820	598	457	430	395

Such large-scale electric plants make it possible to save millions of tons of natural fuel for the national economy. In 1957 the consumption of conventional fuel per one kilowatt-hour of electric power was half that in 1913, and the 363 gram decrease in specific consumption of conventional fuel at rayon electric power plants between 1957 and 1928 saved the national economy more than 40 million tons of comparison fuel.

It should be noted that efficiency is increased in thermal electric power plants when the pressure and the superheating vapor temperature are raised (Table 3).

Table 3.

Consumption of Fuel (g) per 1 kilowatt-hour with Relation to Vapor Pressure (atm) and Temperature (°C).

Pressure	90	140	200
Temperature	500	565	600
Fuel Consumption	380	340	320

An extensive network of large-scale thermal electric plants is being created in our country, especially in the eastern rayons of the USSR. The Nazarovskaya State Regional Electric Power Plant with a capacity of 1,200 thousand kilowatts was built in the Krasnoyarskiy Kzay. It will use coal from the Kansko-Achinskiy Basin, which extends almost one thousand kilometers and which has a coal bed about 100 meters thick. The fuel can be obtained here by the open pit methods with excavators. The thermal electric power plants which will operate on this fuel can produce electric energy which is just as cheap as that produced by hydroelectric plants.

An increase in the number of thermal electric power plants in the eastern rayons depends on the economic needs of these rayons, and recently their growth has been very rapid. As a result of the accelerated construction of thermal electric power plants,

the economy of the eastern rayons will be receiving a much larger amount of electric power.

Forced construction of thermal electric power plants requires an acceleration in the production of high-quality equipment, in particular turbogenerators of great capacity and high-duty boilers. USSR industry produces turbines with capacity of 150 thousa nd kilowatts at three thousand rev/min, with beginning pressure of 170 atm and 550°C temperature. A turbogenerator was also constructed with a capacity of 200 thousand kilowatts. A technical design for a turbine with a capacity of 300 thousand kilowatts was completed.

Recently a design has been drafted for thermal electric power plants with a capacity of 2,400 thousand kilowatts, which will be the most powerful in the world. It is planned to set up units of 600 thousand kilowatts with vapor parameters of 240 atm and 580°C. The boilers, operating in a block with similar turbines, will produce 1,800 t of vapor per hour. Auxiliary mechanisms will be necessary to service the units; for example, a feed pump for the boilers producing more than 1,800 cubic meters per hour at 300 atm pressure. A steam turbine with a capacity of 24 thousand kilowatts will drive the pump.

A thermal electric power plant of this type will require a large amount of crushed fuel: 1,600 t of coal per hour. In order to convert this amount of fuel into a fine powder, a special plant which dries and prepares the powder is necessary.

The cost of building an electric power plant with 600 thousand kilowatt turbine units is 27% less than for a plant with 200 thousand kilowatt turbine units. And the price of the electric power which it generates will be 1.5 - 2 times less than that of the thermal plants which are presently in operation.

In order to present a more accurate picture of our successes in this field, we would like to point out that in the United States the maximum power of the turbine units which they plan to construct in the coming years is only 450 thousand kilowatts.

During the Seven Year Plan a large number of thermal electric power plants will be run on gas. The construction of 17 large-scale gas thermal electric power plants is presently being planned. The transportation of fuel, removal of ashes, and many other complicated and costly procedures will not be needed at these electric power plants. If boilers which consume only gas and fuel oil are used, it will be possible to reduce the capital expense per kilowatt by approximately one-fifth, and in addition construction costs are considerably lower.

It is planned that by 1965, 50-55 billion cubic meters of natural gas will be used in industrial boiler works and in electric power plants. Later this amount will be increased up to 90-100 billion cubic meters, which is equivalent to 110-120 million tons of conventional fuel.

If an inexpensive fuel such as gas is used extensively, it will be possible to achieve an enormous saving in the amount of

labor which is required. In particular, this would provide for a considerable rise in the efficiency of the thermal electric power plant.

Thermal electric power plants operating on gas could be easily converted to liquid fuel. The Ali-Bayramlin electric power plant and others will be of this type. Gas turbine installations with a capacity of 25 thousand to 50 thousand kilowatts are also built for thermal electric power plants. At the present time, the largest gas turbine in the world operates at the Betznau Electric Power Plant in Switzerland with a capacity of 27 thousand kilowatts. A Swiss firm is presently working on the construction of gas turbines with a capacity of 40 thousand kilowatts.

Thus, our gas turbine installation with 50 thousand kilowatts, the technical design for which is now being worked out, will be the most powerful gas turbine construction in the world. In addition to this, it will be more economical than any other thermal engine of the same capacity. At a low outside temperature, its capacity can be increased to 60 thousand kilowatts. The unit expense for metal on this turbine is 2-3 times less than for a steam turbine of a similar capacity.

A gas turbine which will operate on natural gas from the Shebelin deposit will be set up in 1960.

It is advantageous to use gas turbine installations with 25 thousand kilowatts at electric power plants with a capacity of 100 thousand kilowatts, and to use turbines with 50 thousand kilowatts at electric power plants with a capacity of 200 -300 thousand kilowatts. At larger condensation thermal electric power plants and thermal electric power plants with large steam and heat distribution, where gas is used as the fuel, a steam turbine will be the main engine as has been done before.

Superpowered, condensation electric power plants with a capacity of 2 - 3 million kilowatts, and one million kilowatt units, very high initial vapor parameters (300 atm. and 650 - 700°), and an interlocking system (boiler-turbine) will be used. In addition, there will be powerful thermal electric centers with 100-200 thousand kilowatt units; gas turbine electric power plants, among which there will be plants operating jointly with plants employing under-ground coal gasification; electric power plants utilizing the newest methods in technological-energy use of fuel; superpowerful hydroelectric power plants located on Siberian rivers with the newest type of hydrotechnical construction, hydro-mechanical and electrical equipment; and cross-country high voltage power transmission of direct and alternating current, capable of transmitting 2 - 3 million kilowatts on one circuit extending over 2 - 2.5 thousand kilometers.

Automation of different types of electric power plants will also take place, along with automatic control by power systems and by a single energy system, utilizing computors with automatic operators installed at lectric power plants and substations. Due to the

great rapidity with which they make calculations, the newest computors can do the work of a single energy system most economically and can automatically provide a continuous supply of electricity, switching over to reserves in case of emergency.

The development of thermification points to technical progress in the field of energetics. This is the combined production of electric power and heat which makes it possible to increase the efficiency of fuel by 25-40%, as compared to the usual condensation electric power plants. Development of thermification can improve urban sanitation and the living conditions of the masses, and can make it possible to use inexpensive fuels.

By 1960 in the USSR, there will be ten steam turbine electric power plants with a capacity of from 600 thousand to 1,200 thousand kilowatts each generating from 5 billion to 10 billion kilowatt hours electric power.

Boilers operating on gas are particularly effective for modernizing existing urban TETs and for new rayon housing.

In our country there are more than 100,000 thermal electric power plants with a capacity of up to 500 kilowatts. On the basis of capital expense, the replacement of outdated equipment and the conversion of boiler TETs into gas TETs will be almost twice as economical as the construction of new condensation plants with power transmission lines and the construction of boiler plants.

A great amount of work has been carried out in recent years on the automation of technological processes in thermal electric stations. Action has been taken to automize all equipment operating with high vapor parameters. Plans which are being made must provide for regulating the operating conditions of the different electrical stations entering the energy system.

Automation of thermal electric power plants makes it possible to save million of tons of expensive fuel each year and to considerably increase the production of electric power in the country.

Data on electric power production is set forth in Table 4.

Table 4.

Electric Power Production (in billion kilowatt-hours)

1913	1916	1957	1958	1965
1.9	2.6	209.7	233	500-520

The enormous increase in electric power production cannot be separated from the construction of thermal electric power stations, which in turn is due to the widespread use of reinforced concrete. In the south original "open" thermal electric power plants were built.

Their units are located in open areas: it has not been necessary to construct either walls or roofs. The construction of these plants is not very expensive, and they can be built in very short periods of time.

Plans are being made to triple the electric systems with voltage of 350 - 500 kilowolts, which will make it possible to more widely encompass the centralized supply of electricity for towns, industry, and rural areas and to reduce the construction of small, expensive, and uneconomical electrical power plants. The task still remains of building interkolkhoz and inter-rayon electric power plants and of further developing thermification of industry and cities.

In stressing the production of electric power in the country by means of thermal electric power plants, the Communist Party is basing itself on the economic possibilities of our country and on the existence of fuel resources. Figures have shown that in our country there are rich deposits of mineral which are necessary for rapid construction of thermal electric power plants.

The Seven Year Plan is a decisive phase in the realization of Lenin's ideas on continuous electrification of our country.

Hydroenergetics.

The energy of river water is the liberated energy of the sun. The average flow of rivers on the earth is approximately 1.2 million cubic meters per second. The theoretic potential power of all rivers on our planet is 3,750 million kilowatts, with a potential yearly energy of 32,850 billion kilowatt hours.

The USSR occupies the foremost world position with regard to the number of lakes and rivers and has the richest hydro-power resources. The USSR holds 11.4% of the theoretic world hydro-power potential.

There are 200,000 rivers (155,000 in the Asiatic part of the USSR) in the USSR extending 3,000,000 kilometers (2.3 million kilometers in the Asiatic part). The theoretic gross potential of hydro=energy, as based on data obtained in 1957, is 420,000,000 kilowatts, or 3,680 billion kilowatt hours.

More than 50 rivers in the USSR have catch basins which are more than 100,000 square kilometers each. The USSR has four of the ten rivers on the earth which have catch basins exceeding 2,000,000 square kilometers: the Ob, the Lena, the Amur, and the Yenisei. The Volga River, with a catch basin measuring 1.5 million square kilometers, is one of the largest rivers in the USSR.

Utilization of the hydro-power resources was stressed during the first days of Soviet rule. The GOELRO (Gosudarstvennaya Komissiya po Elektrofikatsii Respubliki - State Commission on Electrification of the Republic) planned to build ten GES's (Gidroelektricheskaya Stantsiya - Hydroelectric Power Plant) with a total capacity of 640,000

kilowatts. By 1935 the GOELRO plan had already been over-fulfilled; instead of ten, 20 GES's had been built with a total capacity of 845,000 kilowatts, generating 3.5 billion kilowatt hours of energy.

Hydro-power construction was widespread in the postwar years. For example, in 1957 the hydroelectric power plants produced 39.3 billion kilowatt hours, which was 18.7% of the total amount of electric power. As the Volga and Siberian giants of Soviet hydroenergetics have come into operation, the role of hydro-energy has increased in the electric energy scale of the USSR.

At the present time in the Soviet Union, there are more than 40 hydroelectric power plants, with a total capacity which is three times greater than that of all the water plants existing in 1956. The construction of enormous hydroelectric power plants in our country has made it possible to increase industrial utilization of electricity. The amount of electric power generated by hydroelectric power plants is shown by date in Table 5.

Table 5.

Hydroelectric Power Production (in billion kilowatt hours)

1913	1917	1957	1958	1965
0.04	-	39.3	46.2	up to 60

There were two hydroelectric power plants in pre-revolutionary Russia: one in Armenia (the Alaverdskaya Plant with a capacity of 800 kilowatt) and one in Central Asia (the Gindukushskaya Station with a power of 1,300 kilowatt). At the present there are more than 100 hydroelectric power plants in operation, not including the Kolkhoz hydroelectric power plants and hydroelectric power plants of different administrations and enterprises: the Tsimlyanskaya, Gyumushskaya, Verkhne-Svirskaya, Mingechaurskaya, Kamskaya, and many others. In 1958 the country proudly marked the commencement of operation of the Volga GES imeni V. I. Lenina, which was the largest in the world. Twenty hydro-turbines were in operation at this plant. After rigid tests, the power of this unit was found to be 115,000 kilowatts instead of the 105,000 kilowatts which had been planned. At a pressure of more than 22 m. the power increased to 126,000 kilowatts. The hydro-turbine had 95% efficiency. The Volga GES imeni V. I. Lenina reached a total capacity of 2,100 thousand kilowatts, and today its power has increased to 2,300 thousand kilowatts. It generates more than 12 billion kilowatt hours of electric power, while the Stalingradskaya Plant, which will be in full operation by 1960, will have a capacity of 2,350 thousand kilowatts.

At Angara, the Irkutskaya Hydroelectric Power Plant was put into operation in 1959 with a capacity of 600,000 kilowatts. Eight

of its units generated 4.5 billion kilowatt hours in a year which is twice that of the Dnieper GES. Construction of the Bratskaya Hydroelectric Power Plant at Angara was started, which will have an overall capacity of 3,600 thousand kilowatts. It will generate up to 21.7 billion kilowatt hours of electric power yearly, which is as much again as the Volga plant imeni V. I. Lenina and the Stalingradskaya Plant combined. It would be necessary to burn 20 million tons of coal per year to generate this amount of electric energy at the thermoelectric plants.

Scheduled figures for development of the USSR's national economy for 1959-1965 provide for the construction of the Stalingradskaya, Bratskaya, Kremenchugskaya, Votkinskaya, Bukhtarminskaya, and other hydroelectric power plants along with the placement of powerful electric plants into operation. Construction is also forecast fir several new hydroelectric power plants located primarily in rayons which do not have sufficient, inexpensive fuel resources. A new hydroelectric power plant, the Krasnoyarskaya on the Yenesei River, with a capacity of 4 million kilowatts is also planned, along with several others. The overall capacity of hydroelectric power plants which can be built along the Yenesei River is 20 million kilowatts, generating 130 billion kilowatt hours per year.

The Siberian rivers make up one half of all the potential water resources in the USSR and are capable of generating more than 900 billion kilowatt hours per year.

By utilizing the hydro-power resources of the Angara and Zenesei Rivers, it is possible to obtain an amount of hydroelectric energy which is considerably in excess of the total 1956 production of electric power in the USSR and to create a foundation for power production in the Soviet Union. Only the Angara and the Yenesei Rivers can generate this amount of electric power, the production of which would require more than 320 million tons of coal per year. Two Siberian hydroelectric power plants - the Bratskaya and Krasnoyarskaya - generate up to 50 billion kilowatt hours per year.

Plans to create a Siberian power base are wide in scope. The power system of Central Siberia has changed this area into a region of coal mining and electric energy. There has been considerable development of the heat and power branches of industry, especially in electrometallurgy, electrochemistry, and also aluminum production, which are based on electro-technology and require large volumes of electric power. For example, up to 19,000 kilowatt hours of electric power are necessary to produce one ton of aluminum, and up to 20,000 kilowatt hours are needed for one ton of magnesium.

There are bauxite and nepheline resources in Siberia for aluminum production. Complex reprocessing of raw nepheline has great economic significance: aluminum production is practically limitless now, since up to the present bauxite has been the only source for aluminum production.

The construction of enormous hydroelectric power plants requires further development of Soviet hydraulic generator production. Hydro-turbines with a capacity of 126,000 kilowatts are produced in the USSR. The total turbine and generator height is more than 30 m., and the total weight is more than 1,600 tons. The power of one such turbine is twice that of the first plant built by the GOELRO - the Volkshovskaya Hydroelectric Power Plant.

The construction of hydro-turbines with a capacity of 250 - 400 thousand kilowatt, for the Bratskaya, Krasnoyarskaya, and other GES's is being projected.

Many interesting and complex technical problems - for example, durability of different units, vibration, selection of highly-resistant materials, etc. - must be solved in order to plan construction of similar units for hydroelectric power plants.

Construction of many hydroelectric power plants can be done with the aid of the new Soviet technology - dredgers with shovel capacity of four to 50 cubic meters, cranes which are 100 - 140 meters long, and others. ESh-14/75, ESh-30/50 and ESh-25/100 type dredgers are being used more and more extensively, with an output of more than 3,000,000 cubic meters per year. There is now a growing need to increase the production of dredgers. Plans have been made for a ESh-50/100 excavator with an output of up to 7,000,000 cubic meters of dirt per year.

By using the highly-productive machines developed by Soviet specialists, it is possible to construct hydroelectric power plants within a specified period of time and thus to increase the power balance in our Motherland.

The Seven Year Plan for developing our national economy for 1959-1965 provides for construction of unified power systems in the European section of the USSR and in Central Siberia, and also for combined power systems in the rayons of the Northwest and the West, the T anscaucasus, Kazakhstan, and Central Asia. This will yield tremendous economic results. These powerful systems will make it possible to provide large amounts of electric energy relatively easily and without interruptions and to cope with rush-hour demands due to the fact that the maximum load of different plants is not uniform.

At the present time a high-voltage power transmission line is being constructed between Kuibyshev and Moscow with a tension of 400,000 volts. Electricity is supplied by an alternating tri-phase current on ferroaluminum leads. The Stalingradskaya Hydroelectric Power Plant will be connected with Moscow. This is a great step forward in the creation of a single high-voltage system in the European part of the USSR. Next, electricity will be supplied between Kuibyshev and the Urals, the Votkinskaya GES and Sverdlovak, the Bratskaya GES and Irkutsk, and so on.

Already the outlines of a high-voltage network throughout the Soviet Union are appearing. The creation of unified power system in the European part of the USSR will make it possible to save the

country a large amount of fuel. Even with our present power systems, a 1% improvement in their efficiency would save the economy hundreds of millions of tons of organic fuel.

In order to put the hydro-power resources of the Asiatic part of the USSR at the service of the national economy, Soviet technology must solve the problem of supplying still more power for a distance of 1,500 - 2,000 km (the electrical supply from hydro-stations on the Ob, Yenesei, Angara, and others). When this problem is solved, the industrial rayons can obtain inexpensive electric power from remote hydro-stations in Siberia.

Right now designs for a single power system, with a production level of approximately 1,000 billion kilowatt hours yearly, are being worked on.

The creation of a unified power system in the USSR is the embodiment of the Leninist idea of electrification of the entire country. It will provide the best utiliaation of the different types of power resources and power equipment (including atomic energy power plants) and the best efficiency of the power base of our national economy. Electric power supply lines will provide electric power to rayons which do not have their own power resources. This will also provide the most effective allocation of our productive forces.

Helioenergetics.

The sum is a gigantic thermonuclear reactor which uses approximately four million tons of hydrogen per second, converting it into helium. This conversion is accompanied by the liberation of an enormous amount of energy which is emitted in the form of light and diverse particles. Only a very small portion of this energy falls on our planet - approximately one-half billionth. But this comprises on the average more than 1,000 kilowatt hours per year for every square meter of the earth's surface. Neither animals nor humans could exist without this light energy, the source of which is located 150,000,000 km from us.

The sun is an enormous incandescent sphere 1,400 thousand km in diameter. (109 times larger than the diameter of the earth). Its surface temperature is 6,000°, and that of its internal strata - about 20,000,000°.

The primary source of all forms of energy which are used in our economy (coal, petroleum, hydro-power, etc.) is in the last analysis the sun.

The sun provides us with liberal amounts of energy, which by far exceed mankind's needs. This energy is widely dispersed in terms of time and space. Consequently, the problem of utilizing it boils down to concentrating it over a small space and accumulating it by conversion into other forms of energy.

During the course of one year, the sun radiates $2.95 \cdot 10^{30}$ kilo-calories upon the earth's surface.

The amount of solar radiation which is retained by the earth's surface is $6.7 \cdot 10^{20}$ kilo-calories per year. On the basis of recent data on the thermal balance on the earth, the power from direct solar radiation which is attained by the earth's surface can be calculated at $7.6 \cdot 10^{13}$ kilowatts, which amounts to $5.77 \cdot 10^{20}$ kilo-calories of this belong to dry land.

The heat is not dispersed uniformly at different points of the earth's surface. The equatorial sections of the earth receive most of the heat. In the USSR the southern regions have the most favorable solar conditions.

At the present time solar energy is used primarily for heating and distillation of water, drying fruits, and occasionally for power. The Soviet Union is planning to build the first industrial solar heat plant in Armenia on the Ararat plain. The solar energy will be concentrated in a thermal-collector using 1,293 flat, movable mirrors, each measuring 15 square meters, which will be located on 23 automatic trains moving along 21 concentric tracks. This gigantic spherical surface will be surrounded by trees to protect the mirrors from dust which could be brought in by wind from the desert.

In outward appearance, the solar electric station will differ greatly both from the thermal electric and hydroelectric power plants. It will look like a circular surface about one kilometer in diameter. In the center there will be a 40-meter tower with a rotating boiler located in the optical focal point of the mirrors. These mirrors will catch the solar rays and direct them into the boiler containing water.

The boiler itself will be a chamber containing a large number of black metallic tubes. The water circulating in them will be heated, converted into steam with a temperature of 400°C. Eleven tons of steam will be formed per hour. The steam will then activate the steam turbine rotating the electric generators. Under a pressure of 35 atm. the steam will set in motion the turbine with a capacity of 1,200 kilowatts. This type of electric power plant will generate $7.2 \cdot 10^{6}$ kilowatt hours per year.

Industrial utilization of solar energy will take place when there are sufficient inexpensive and technically-reliable methods of converting solar energy into electric energy using semi-conducting photo- and thermocells, which are highly efficient with the natural voltage of solar radiation.

The solution of these problems dealing with utilization of solar energy will be of great significance. It will require a great deal more scientific research work before solar energy can be utilized in the national economy, before other forms of energy can be obtained from solar rays, before the sun can be used to turn motors, and before electricity can be generated.

The ideal situation would be the conversion of solar energy into electric energy without using a thermal engine. Previously this was considered impossible. However, this conversion is theoretically possible when a photoelectric battery is used. A similar electric

power plant will be constructed in the USSR after the electric power plant at Ararat Mountain is in operation.

It is apparent that in the not too distant future mankind will master solar energy and will have an inexhaustible source of energy.

Soviet research on solar energy has shown that helio-technology has great and varied possibilities. At the present time it is impossible to envision all the uses for solar energy, since mankind will constantly be presenting new demands on helio-technology.

What will be the practical development of solar apparatus in the near future?

It is safe to assume that solar plants generating steam for industry and agriculture in the near future will be a surprise to no one. These plants will be able to supply steam to different parts of the people's economy. Solar energy will also be used to prepare dinners, suppers, and breakfasts.

It is possible to construct enormous solar plants in the south for centralized heating of city blocks and of entire cities. Simple and inexpensive semi-conducting installations are very possible and will make it possible to use solar rays for heating homes or for cooling them. They can be mounted on the sides of houses.

At the same time other solar apparatus, mounted on rooftops, can heat water and can supply electric energy for domestic appliances and lighting.

Refrigeration installations for cooling air in warehouses storing perishable products, for making ice, and also for air conditioning in homes, hospitals, theaters, movies, etc., will be very widespread.

In addition to solar apparatus for everyday living and salt water distillation, there will be solar water pumping machines which are greatly needed for irrigation. Solar ovens will melt metals which require specific purity, particularly metals for semi-conductors (for example, germanium). These ovens will probably be used for testing diverse fireproof materials used in rocketry.

It is entirely possible that in Central Asia there will be stationary and portable solar apparatus for welding metals.

The construction of evaporation tanks will be improved in order to intensify the technological processes for producing certain chemical substances, and hot air obtained from solar apparatus will be used for drying processes.

The use of solar reflectors over a long period of years for medical purposes has had very good results, and in the future heliotherapy may be widely used for healing certain diseases, and also for general prophylaxis in mines, the chemical industry, children's sanatoriums, and so on.

It is possible that there will be hydroelectric power plants in the south making use of the difference in level between large reservoirs and the desert below.

An important task for the future will be the intensification of natural photo-synthesis, that is, the process of catching solar energy by crops, and growing "two spikes of grain where earlier there was one."

Helio-technology is a new, fast-developing science. However, at the present time there is an actual possibility of introducing the most simple apparatus in order to save fuel and to improve the working and living conditions of the population in the southern rayons of the Soviet Union.

The widespread development of helio-technology on the basis of progress in other sciences opens up additional sources of inexpensive thermal energy both for industry and the public, and also for agriculture.

Fuel Industry.

The development of the petroleum and gas industry is a decisive step on the path toward further improvement of the fuel balance as planned for the national economy for 1959-1965. It is thus planned that the petroleum and gas industry must supply fuel not only for motors and public needs, but also for industrial concerns, electric power plants, and for railway and water transportation.

The expanding use of petroleum and gas as a technological and power fuel and as a raw material for the chemical industry makes it possible to improve the utiliaation of fuel and raw material resources and to economize on labor.

Petroleum. In present-day economies petroleum occupies a very important position. Motor fuel and lubricating oils are obtained from it, without which the airplane, automobile, locomotive, nor any other engine could operate. It serves as a raw material for preparing numerous chemical products - synthetic resins and plastic materials. synthetic fibres, rubber, drugs, lacquars, dyes, and many others.

Soviet oil workers have mastered new methods for exploiting petroleum deposits. Different methods for artificially maintaining the pressure in petroleum beds have been used successfully. Soviet turbine drills and electric drills are considered to be the best in the world.

In recent years the Communist Party has taken measures to accelerate the development of the petroleum industry and to increase the proportion of petroleum in the country's fuel balance. This represents an enormous saving to the national economy, since the net cost of one ton of petroleum is 3.5 times cheaper than one ton of coal.

Before the war, the USSR had the largest petroleum resources in the world (6.4 billion tons, i.e. 55% of the world's resources). Prospecting and geological exploration was very extensive in the Soviet Union during the postwar years. In connection with the dis-

covery of many petroleum deposits, the industrial petroleum reserves in the USSR have grown considerably, as compared with the prewar reserves.

The data in Table 6 attest to the tremendous growth of petroleum in our country.

Table 6.

Growth of Petroleum Production

1913	1917	1957	1958	1965
6.2	8.8	98.3	113	230-240

The volume of petroleum production between 1959-1965 will fully meet the needs of the national economy for petroleum products and will considerably improve the quality of automobile gasoline, diesel fuel, and oil.

Gas. One of the basic tasks of the new Seven Year Plan is to shift the fuel balance by the development and production of the most economical types of fuel. One of these fuels is gas. The labor input on one ton of natural gas is 200 times less than the labor input on a ton of coal, and the net cost is almost 12 times less.

By 1965 the country must have 150 billion cubic meters of gas. On the basis of its heat value, this amount of inexpensive and effective fuel is equal to the combined yearly production of coal from the Donets, Pechora, and coal basins located close to Moscow.

The Seven Year Plan stipulates extensive construction of installations for the gas industry. Capital investment will be over four times more. Several enormous electric power plants will operate on gas. Approximately 26,000 kilometers of main gas pipelines and branch pipelines will be constructed between them and various cities, using pipes up to one meter in diameter. These threads of steel will connect the Central Caucasus with Leningrad, Bukhara with the Urals, and Saratov with Cherepovets. Hundres of towns will receive considerable amounts of fuel gas.

Gas is not only a fuel. It is a source of hundres of different products. It is only possible to obtain hundreds of thousands of tons of polyethylene, alcohol, and synthetic rubber from gases, extracted along with petroleum, in the Bashkir, Tartar, and Kuibyshev Oblasts. Gas is one of the buttresses of chemistry.

The USSR has enormous resources of natural gas. In 1936, when geological data on our country was inadequate, our gas resources were estimated at 936 billion cubic meters. During the last 23 years, rich gas deposits have been discovered in our country. The existence of great resources makes an increase in natural gas production highly possible.

At the present time it is calculated that natural gas resources in the USSR equal 1860 billion cubic meters, prognosticated resources are calculated at 19,300 billion cubic meters, and potential resources at 60,000 billion cubic meters.

Data regarding the growth of gas production in our country is given in Table 7.

Table 7.

Gas Production
(in billion cubic meters)

1913	1917	1957	1958	1965
0.02	=-	20.24	29.8	150

Automation and remote control will be used in the petroleum and gas industries as basic technological processes for petroleum and gas installations, petroleum reprocessing factories, and all main oil pipes, and gas pipes.

Coal and Peat. This is one of the main sources of heat production and electric power, and the basic raw material for obtaining coke, without which ferrous metallurgy could not exist. Diverse chemical products are prepared from coal. Although coal has been successfully replaced by natural gas in many fields of production in recent years, coal is still of tremendous significance in the national economy.

According to estimates made in 1956, coal resources are approximately 9,000 billion tons. In accordance with international regulations, estimates were made for coal extending down to a depth of 1,800 meters. We have 3,000 billion tons of coal which can be extracted by present-day methods, that is, 53.8% of total world resources.

Data on the growth of coal production in our country are given in Table 8.

Table 8.

Coal Production
(in million tons)

1913	1917	1957	1958	1965
29.1	31.3	463.4	496	600-612

It is highly possible that in the near future coal will no longer be used as a fuel. To the extent that the proportion of atomic, hydro-, helio-, air, and other types of energy grows in general production processes, combustible substances such as coal will be considered mainly as chemical raw materials.

Coal is a valuable mineral which can be used by mankind in many different ways. In the hundreds of years to come, its enormous reserves will be a source of energy and will serve as raw material and technological resource for different branches of the national economy.

Widespread utilization of coal and its products became possible due to knowledge regarding the composition and properties of coal and due to scientific advances, especially in chemistry.

Chemistry discovered new horizons in the use of coal. And there is no doubt that in the near future new applications of coal will be discovered - new application for this inexhaustible source of raw material for "creative chemistry."

The more varied are the uses for coal, the greater will be the need for it. The time is passed when coal was needed only for obtaining metallurgical coke. Today there is not one branch of the national economy which is not connected with utilization of coal to a greater or lesser degree.

The existence of enormous coal reserves in the USSR makes it possible to increase gas production by their underground gasification, which is one of the most important ways to accelerate construction of thermal electric power plants. Even in 1888 the great Russian teacher D. I. Mendeleev wrote that "it is probable that the time is approaching when coal will not be mined out from the ground, but will be converted into hot gases which will be carried over great distances by pipelines."

This idea was highly valued by V. I. Lenin. In the Article Odna iz velikikh pobed tekhniki - (One of the Great Victories of Technology) [See Note], he points out that underground gasification of coal will create a gigantic technical revolution: it will make it possible to use "twice as much energy, contained in the coal, than was possible with steam engines."

([Note:] V. I. Lenin, Works, Vol 19, page 41.)

The process of underground gasification can be readily regulated, and can make it possible to obtain a large amount of inexpensive gas each year for production of thermal or electric energy.

Increased construction of thermal electric power plants is quite realistic because our country has a sufficiency of coal and peat, in addition to petroleum and gas.

More than 60% of the world peat reserves are concentrated in the USSR. Last year the proportion of peat in the thermal balance was 5%, as opposed to 1% in 1913.

The total world area of industrial peat has been estimated at 1,083 thousand square kilometers, and the total amount of organic substances tored in peat bogs on conversion to carbon has been estimated at 482 billion tons, or 562 billion tons of ideal fuel.

It is obvious that peat reserves with industrial significance are far less than this figure. In the Soviet Union peat reserves have not been exhausted.

Thus, the Soviet Union has everything that is necessary for increased construction of thermal electric power plants. In the coming years, new GRES's and TES's will give a tremendous boost to the pool of electric power, and this will make it possible to increase industrial production and consumer goods even more.

Due to the development of the petroleum and gas industry, the thermal balance has changed in the following way (Table 9.)

Table 9.

Changes in the Thermal Balance

Types of Fuel	Proportion of the Different Types of Fuel in the Total Balance of the Country (in %)		
	1955	1958	1965
Coal	64.8	59.0	43.0
Wood	5.4	5.0	2.4
Peat	4.4	4.3	2.9
Slate	0.6	0.7	0.7
Petroleum	22.4	26.0	33.5
Gas	2.4	5.0	17.5

Consequently, the proportion of petroleum and gas will have grown from 24.8% in 1955 and 31% in 1958, to 51% in 1965.

ATOMIC ENERGY

Soviet technical thinking has successfully solved the main problems of present-day technology. An example of this is our control of atomic energy. On 27 June 1954 the first atomic energy station with a capacity of 5,000 kilowatts started generating electric power in the USSR.

Our atomic power station has opened up a new field for atomic nergetics. Its uninterrupted operation has made it possible to accumulate a large store of knowledge and to discover paths for further utilization of atomic energy in the world.

= An atomic power station has a great advantage over thermal electric power plants which operate on normal fuels. There is a high concentration of energy only in nuclear fuel. This means that the fuel in an atomic power station takes up very little space. If the energy of all existing atomic nuclei is utilized, one piece of uranium with a volume of 14 cubic cm can generate as much energy as 1 million cubic meters of fuel gas, 800 cubic meters of coal, or 470 cubin meters of petroleum (see Table 11).

Thus, there is practically no fuel transpottation problem in atomic power stations. The construction of such stations is most expedient in rayons which do not have cheap fuel. It is obvious that measures must be taken in an atomic power station to protect the personnel from radioactive radiation of the nuclear reactor. It is for this reason that the nuclear reactor is surrounded by thick, concrete walls, and the reactor is controlled and loaded and unloaded by automation.

Control of atomic power will greatly expand our energy reserves. Nuclear power stations will be put into operation along with thermal and hydroelectric power plants.

In accordance with the plan for constructing atomic power stations in the USSR, in September 1958 a new atomic power station with a capacity of 100,000 kilowatts was put into service. Its maximum capacity will be 600,000 kilowatts.

A nuclear power station with a power of 5,000 Kilowatt will consume up to 30 g of uranium daily (more accurately - of its isotope uranium - 235), while a station with a power of 100,000 kilowatts will consume up to 400 g of uranium - 235. A thermal electric power plant with a capacity of 100,000 kilowatts must consume 500,000 tons of coal per year, while a nuclear power station of similar capacity will consume 150 kilograms of uranium-235.

Widespread utilization of atomic energy for peaceful purposes is included in the plan for development of the national economy for 1959-1965. Many atomic power stations with different types of reactors will be put into operation.

An atomic power station is being constructed at the present time in the Voronezhskaya Oblast which will have a hydraulic type of reactor. Water under 100 atm. pressure will be the heat conductor in this reactor; it will pass through a steam generator, thus producing saturated vapor with 29 atm. pressure which will then enter the turbines. Heat-liberating cells of uranic oxide will be used in the reactor.

Concentrated uranium will serve as fuel for the Voronezh atomic power station (i.e., uranium with high isotope uranium-235 content), The reactor can be loaded with 44 tons of fuel, which is sufficient fuel for one-half year's operation.

The reactor has walls up to three meters thick. The weight of the reactor minus water is 420 tons. The active zone of the reactor is contained in a highly-resistant steel container 3.8 meters

in diameter and 12 meters high. The efficiency coefficient of the station is 26.3%.

As knowledge is accumulated on the operation of this type of reactor, it is assumed that these reactors will generate vapor which will pass directly into the turbines. In this case there will be no need for intermediate steam generators or for auxiliary equipment.

At the present time there is an experimental hydraulic reactor with a capacity of up to 50,000 kilowatts located on the Volga, in the Ul'yanovskaya Oblast. This reactor has heat-liberating cells which are similar to those in the reactor at the Vornezh Station.

Experimental power reactors of a different type are being built on the Volga, and an anormous center for conducting scientific and technical experiments in the field of atomic energy is being created there. The importance of this center will derive from the fact that reactors can be tested under industrial conditions.

The idea of obtaining steam in the atomic reactor itself is at the basis of a technological project in the Urals for the Beloyarskaya Atomic Energy Station which is presently under construction. The reactors at this station will represent a further development of the reactor used at the first atomic energy station.

Each of the reactors will operate jointly with a turbine with a capacity of 100,000 kilowatts. The steam will pass directly from the reactor into the turbine under a pressure of 90 atm. and temperature of 480 - 500°C. Low-concentration uranium will serve as the fuel, and graphite will serve as the moderator and reflector. The stack of graphite will be 9 m high and 9.6 meters in diameter. The reactor will be loaded with enough uranium to last for two years of continuous operation. The efficiency coefficient of the station will be 33.8%.

There will be a layer of graphite over the active zone of the reactor which will be one meter thick, along with a cast iron slab 0.5 meters thick. This will serve to protect the reactor from above. In addition to a one-meter belt of water, there will be thick concrete walls around the reactor. The walls will be up to three meters thick.

By 1961 the Beloyarskaya Atomic Energy Station will be supplying industrial power to the Ural region.

A nuclear reactor, steam generators, and steam turbinee with electric generators will serve as the basic equipment for the atomic electric xtation, whose construction will follow that of the Soviet atomic electric station which was the first to be built in the world.

As a rule there will be two basic ways of circulating the water in an atomic power station: the first - for transferring heat from the reactor to the steam generators; the second - for transferring steam from the steam generator to the turbines with electric generators.

Water for the first purpose, under several tens of atm pressure, will be heated in the reactor up to a temperature of several hundreds of degrees and then will be passed into the steam generators, where water for the second purpose will be heated. It will be converted

into saturated steam with a temperature of several hundreds of degrees and with high pressure also. After it has bean cooled, the water for the first purpose will be returned to the reactor by means of special circulating pumps, thereby completing the cycle.

After having been first dried in separators, the steam for the second purpose will pass into the turbine.

The thermal equipment for the turbine section of the atomic energy station will not differ from that of the usual thermoelectric station.

At the present time it is possible to liberate and utilize atomic energy only by splitting uranium and plutonium nuclei. It is very doubtful that in the future there will be an increase in the number of substances used for atomic energy production. The total reserves of nuclear energy in nature is practically infinite. One kilogram of any substance contains within itself an amount of neclear energy which is equal to the chemical energy of 2.7 millions tons of coal, or 25 billion kilowatt hours of electric power. This is 2.5 times greater than the amount of energy generated in one year by the Volzhskaya GES imeni V. I. Lenina. However, ways to utilize this energy are still unknown.

Science is not only working on the problem of increasing the number of substances which can be used for liberating nuclear energy, but also on the problem of increasing the amount of energy liberated by nuclear fission reactors. The more rapid is the expansion of peaceful uses for atomic energy, the more will be methods perfected for liberating and utilizing it.

The power potential of world reserves of different fuels can be seen from the following figures (Table 10):

Table 10.

Potential World Power Reserves of Different Fuels

Name of Fuel	Energy Content 10^{15} (in kilowatt hours)
Natural gas	0.17
Petroleum	2.22
Coal	21.10
Uranium + Thorium	519.00
Solar Energy Striking the earth in the course of one year	1,500.00

The nuclear power reserves, the estimation of which is far from complete, have been calculated at 519.10^{15} kilowatt hours, i.e., 20 times greater than the other types of fuel. If it is assumed that

the yearly world power needs are $3 \cdot 10^{12}$ kilowatt hours, then, using the 25% efficiency coefficient, the uranium and thorium reserves are sufficient for 43,000 years $(0.25 \cdot 519 \cdot 10^{15}) : (3 \cdot 10^{12}) = 43 \cdot 10^{3}$ years.

At the same rate of power consumption, the coal reserves will last 1,760 years, and petroleum reserves will last 185 years. In actuality, taking into account constant growth of power installations and of consumers, petroleum reserves will be exhausted in 25-50 years, and coal reserves - in 300-400 years.

After the data set forth in Table 10 is considered, it can be seen that the amount of energy falling on the earth in the form of solar radiation is extremely important. Its yearly total is almost 2.75 times greater than all power reserves in nuclear and organic fuels.

Nuclear energy will not replace the other types of energy which are presently being used all at once. However, it will play an increasingly important role, particularly in those areas with no inexpensive power sources.

Thermonuclear Reaction.

Among problems connected with utilization of atomic energy, that of controlling thermonuclear reactions is of great significance. Controlled thermonuclear reactions make it possible to obtain energy not only from the atomic nuclei of rare elements such as uranium and thorium, but also from substances which are common in nature due to the formation of helium from hudrogen. These reactions are the source of tremendous energy which has never before been seen on this earth.

In recent years scientists have studied controlled reactions for fusing (synthesis) the light hydrogen nuclei to the heavier helium nuclei. This reaction can be carried out only at very high temperatures. At normal temperatures the thermal traveling speed of air molecules is on the average 400 - 500 m per second. The fusion of atomic nuclei at such speeds is impossible, since the repelling force operating between the nuclei is enormous (the greater it is, the greater the nucleus charge) and keeps them from coming in contact.

Hydrogen nuclei have a minimum charge. Therefore, the repelling force between them is the least of all. Due to this fact, the most rapid hydrogen nuclei can come in contact and fuse together in heavier nuclei, even starting at a temperature of about 400,000°.

At million degree temperatures, there is a mass collision of hydrogen nuclei. A nuclear reaction which takes place at a high temperature is called a thermonuclear reaction.

At first a thermonuclear reaction took place in the hydrogen bomb. The hydrogen bomb was filled with heavy (deuteric) and superheavy (trithic) hydrogen. Inside of it was placed the atomic bomb which served as a detonator - operating on an "incendiary" principle. The explosion of the atomic bomb would "ignite" the hot hydrogen mix-

ture and set off a thermonuclear reaction. In a very short period of time an enormous amount of energy is liberated and an explosion of tremendous force is set off. A more difficult problem is to keep a thermonuclear reaction in check, to control it so as to perform useful work. One of the main elements of this problem is that of building a container within which a thermonuclear reaction could take place, with the liberation of a large amount of heat. All of the materials with which we are familiar would melt and volatilize under the high temperatures of a thermonuclear reaction.

Technology has taken only the very first steps on the path toward a solution of this problem. Scientists have proposed a very original "container" for the hot plasma. Its "walls" are a strong magnetic field which can serve as a very reliable "container" for the entire thermonuclear process.

In order to solve the problem, it is also necessary to learn how to produce instantaneous multi-million degree temperatures inside the "container" holding the hydrogen plasma-mixture of hydrogen nuclei and the electrons which have been severed from them.

One of the methods for heating the plasma consists of compressing the plasma by changing the magnetic field. "Injecting" ions into the plasma (of electrically-charged particles of atoms or groups of atoms), which have previously been accelerated up to the requisite energy; using powerful, brief electrical discharges, etc. are other ways of doing this also.

The experimental installation "Ogra" has been built in our country to produce super-high temperatures. It consists of a vacuum chamber 140 cm in diameter and about 10 meters long. Air is pumped out of it up to several billion atms. of pressure by means of special pumps. A powerful magnetic field is created by a cover which has an average diameter of 180 cm. It is made up of many sections, thus making it possible to create a magnetic field with different configurations inside the chamber. With this type of apparatus it is possible to observe the behavior of the plasma in different electromagnetic fields.

When the problem of controlling thermonuclear reactions is solved, a new era will emerge in the evolution of mankind, and the eternal quest for power reserves on the earth will amost be at an end. There are almost infinite reserves of substances which can be used for thermonuclear reactions on our planet. This applies particularly to heavy hydrogen, which is a component of heavy water, and heavy water is found in normal water in the form of an admixture.

It is a well-known fact that the hydrosphere of our planet (i.e., the water in all the seas, oceans, lakes, and rivers) weighs $15.8 \cdot 10^{17}$ tons. Up to 25,000 billion tons of deuterium are found in this amount of water, and each gram of deuterium can liberate 100,000 kilowatt hours.

Consequently, the heavy water contained in the world's oceans has $25 \cdot 10^{23}$ kilowatt hours of energy. The latent energy in deuterium

would last mankind many billions (900 billion) of years.

As we have already pointed out, a characteristic of nuclear energy is its extremely high concentration - a million times greater than the energy concentration in normal fuels. The energy liberated by complete consumption (combustion) of a kilogram of fuel is called the calorific value of the fuel (thermal combustion). Let us consider the calorific value of nuclear fuels and how to calculate it.

About 10,000 kilocalories are liberated by the total combustion of a kilogram of petroleum. This can be called the calorific value of petroleum. The calorific value can be expressed more accurately in kilowatt hours for nuclear fuels (one kilowatt hour is equivalent to 860 kilocalories).

Data regarding the amount of energy liberated by combustion of one kilogram of fuel are shown in Table 11.

Table 11.

Amount of Energy Liberated by Combustion of One Kilogram of Fuel

Name of Fuel	Kilowatt hours
Coal	8
Petroleum	12
Kerosene	20
Uranium	20.10^6
Deuterium	100.10^6

Research by Soviet physicists on the possible existence of controllable thermo-nuclear reactions in powerful, impulse, gas discharges is of great importance in the field of controllable nuclear reactions. However, right now it is very difficult to say in what direction lies success in solving the grandiose problems of peaceful utilization of thermonuclear reactions.

It can be noted that there are two possibilities for utilizing energy of thermo-nuclear reactions. The first possibility consists of the slow "combustion" of the nuclear mixture. This type of thermonuclear reaction takes place on the sun and on the stars. This could lead directly to the creation of an artificial, small "sun" on the earth.

The creation of a "sun" on the earth sounds like phantasy. But, are power stations utilizing the nuclear energy from uranium fission, or engines run by atomic fuel on the atomic ice breaker "Lenin", fantasy? When we are able to produce a controlled thermonuclear reaction, then we can create a "sun" on the earth.

Naturally, this is extremely alluring. However, there are grave doubts that it is possible to carry out a slow thermonuclear

reaction. Thus, the second possibility remains. It consists of utilizing small explosions in the hydrogen mixture. In order to do this it would be necessary to "ignite" the mixture in small portions. After the first portion has burned out, the next portion would be passed into the apparatus and "ignited". This is similar to the operation of an internal combustion engine, for example, a diesel. Here also the fuel is injected in portions, igniting instantaeneously and causing the ignition stroke of the engine.

Apparently, the correct solution of this problem is to create reactive engines using thermonuclear reactions.

Naturally, this possibility for using thermonuclear reactions is less desirable than slow combustion. For each explosion it is necessary to consume part of the energy for obtaining super-hig temperatures in the mixture. However, the amount of energy liberated by each explosion can be much greater than that which is consumed. One should not overlook the enormous concentration of energy in a thermonuclear fuel. Thus, an ordinary balloon with a compressed mixture of light gases will contain an energy reserve equal to the heat liberated by the combustion of about 2,000 tons of gasoline.

If scientists are able to achieve a slow combustion of a thermonuclear mixture - to create a "sun" on the earth - , then one difficult problem still stands before them. It will be necessary to learn whether it is possible to make full use of the energy produced in thermonuclear reactors. Part of this energy will be carried away by neutons which would have been formed by nuclear fission. Apparently, these neutrons will be used for obtaining plutonium from uranium and uranium-235 from thorium, i.e., for increasing the nuclear fuel reserves. There is also the possibility that the energy of the plasma resulting from the thermonuclear reactions will be directly converted into electric power. However, a large amount of energy will be dissipated in the form of radiation. Will it be possible to make use of it? It is very probable. We are already able to use solar energy.

Studies have shown, for example, that very pure silicon crystals convert about 7% of the light energy falling on them into electric energy. It is very probable that chemical compounds may be discovered in the future which will even more effectively convert light into electricity. It will be possible to use such substances for employing solar energy in industrial concerns, and in the future for artificial "sun" systems in which a controlled thermonuclear reaction can take place.

In conclusion, it will apparently also be possible to utilize the energy from an artificial thermonuclear "sun" for photosynthesis. It is a well known fact that plants absorb up to 40% of the solar energy falling upon them. Due to a process of photosynthesis they form energy reserves in organic substances. In burning a chemical fuel, we utilize this energy. It is very possible that in the future by using thermonuclear reactions and accelerated photosynthesis it will be advantageous to form an artificial, chemical fuel which can

then be used for electric plants and for transportation purposes.

It is natural that all of these ideas are still speculation, but there is a strong, scientific base underlying them. There is a great deal of work to be done by the scientist before these speculations can become actualities.

However, there is no doubt that if the scientists of all countries work in close cooperation for the good of mankind, energy which is greater than any other previously known to us - the energy of nuclear fusion - will be supplied to mankind.

Synchrophasotron.

A systematic assault of the Soviet physicists on the atomic nucleus and their penetration into the innermost secrets of nature is becoming more intensive all the time.

For many years physicists studying simple particles have only been able to use the stream of cosmic rays falling on the earth from outer space as their instrument of study. Cosmic radiation was the only source of information about the processes which were occurring, when a particle with great energy collided with atomic nuclei. However, it has been common knowledge for a long time that it is impossible to conduct an intensive study of these new processes by using cosmic radiation. Only when artificially created cosmic rays are available to us can science really discover the nature of nuclear power.

It is well known that the minimum energy of cosmic radiation particles is approximately 10 billion electron volts (an electron volt is the energy which an electron in an electric field acquires, with the potential difference in one volt running through it. An electron volt is much less than a unit of energy such as the erg. One electron volt equals $1.6 \cdot 10^{-12}$ erg). The fact that the most powerful accelerator of charged particles in the world has been put into operation at Dubne has made it possible for physicists to have the first artificial cosmic rays.

Thus, our scientists and engineers have obtained more energy than that obtained in any other research laboratory in the world in the field of accelerators - the basic instrument for studying properties of simple particles.

Science has demonstrated that all substances are made up of atoms, which in turn are formed from various "elementary" particles. Whey are these particles called "elementary"? Only because their internal structure has not yet been studied. Naturally, physicists know that these particles are not elementary and that they have an internal structure of which we are not aware. They can interchange with each other, and their properties are determined by nuclear forces - forces operating within the atomic nucleus. In order to determine the nature of the nuclear forces, it is necessary to study the bond between the various "elementary" particles, to explain their role in

the nucleus of the atom. The most effective way to solve these problems is to study the interaction between the rapid particles.

Present-day accelerators make it possible to produce dense streams of rapid particles - nucleons and mesons. Consequently, they also make it possible to study the internuclear world, to penetrate its secrets. The greater the energy of the accelerated particles, the greater the possibilities for studying the atomic nucleus.

In April 1957 a synchrophasotron was put into operation at Dubne - a proton accelerator transmitting super-high energy. The synchrophasotron accelerated the protons up to 10 billion electron volts.

This installations for accelerating high-energy particles has given physicists a powerful instrument with which to carry out further studies in the field of nuclear physics.

The principle of gradual accumulation of energy underlies all present-day accelerators. It is transmitted to the particles from an electric field.

There are two types of accelerators which can be built on this principle: the first - the so-called linear accelerators which are mainly used for accelerating light particles - electrons; the second is the cyclic accelerator, which produces the greatest energy.

A circular electromagnet is a basic part of present-day cyclic accelerators. A vacuum chamber, from which the air is pumped out, is located between its poles. Charged particles, for example protons, are introduced into the vacuum chamber, and under the effect of the magnetic pole they begin to move along a trajectory close to the periphery. It is possible to do this if the charged particles are placed in the magnetic field. To do this the particles periodically produced a portion of energy, the electric field became alternating, and thus its phase of change coincided with the phase of orbital revolution by the particles.

A powerful accelerator, such as a synchrophasotron, is a tremendous industrial establishment 335,000 cubic meters in size, with electric plants, radio stations, automation, and the most recent machine technology.

The magnetic system of this circular accelerator weighs 36,000 tons, the surface diameter is 72 m, the orbit around which the particles move is 28 meters in radius. A linear accelerator, producing a pencil of particles with nine million electron volts, is used as the injector, "injecting" the scattered protons into the chamber. Within 3.3 seconds the protons attain an energy of 10 billion electron volts while making several million revolutions.

The magnet on the synchrophasotron is fed by powerful transformers. The impulse power of all the units supplying this apparatus with an electric current reaches 140,000 kilowatts. The accelerated beam of particles enters the testing chamber through a slot in the concrete wall which is eight meters thick.

The successful operation of this gigantic atom machine, which has no equal anywhere in the world, will be still another indication

of the high level of Soviet science and technology.

At the present time plans are being compiled for an even more powerful accelerator with 50 billion electron volts. Its construction will give new impetus to the development of nuclear physics.

There is a tremendous group of fundamental problems which can be solved by a synchrophasotron.

The history of physics clearly shows that almost all of our information on the structure of the atom and its nucleus, the nature and properties of electrons, mesons, and nucleons, has been obtained by physicists as a result of studying the processes accompanying the collison of these particles with nuclei and nucleons, particularly the collision of high-energy particles.

A study on the collision mechanism of electrons with nuclei has clarified the cascade processes characteristic for light particles and has led to the discovery of mesons. It is well known how much a study of the various nuclear reactions, which were caused by bombarding the nucleus with atomic particles, has done for the problem of atomic nucleus.

The number of physical studies which can be carried out on the synchro-cyclotorn is rapidly growing, and there is no doubt that in the near future scientific results of great importance will be obtained which will promote the advancement of science even more rapidly.

Radioactive Isotopes.

An important, peaceful application of nuclear energy is the use of artificial radio-active isotopes in various branches of technology and medicine, in industry, and in agriculture. "Tracer" atoms will be used more extensively as the production of radio-active isotopes increases. They have become an important tool for research in biology. The atoms of radio-active substances are called "tracer" because they can always be detected by their radiation. By introducing any substance, with an admixture of a small amount of radioactive atoms from this substance, into the organism of a human, an animal, or a plant, it is possible to trace their passage and speed, the spot at which they accumulate, and thus to clarify certain questions which are important in the study of biological processes. By this method the life processes can be studied without any infringement upon their normal action. The method of "tracer" atoms is of revolutionary significance for biology and medicine.

We shall consider only a few examples here.

Engineers and metallurgists must calculate the time required for gases to pass through a blast furnace. Very recently radioactive substances have been used for this purpose: pa4ticles of a radioactive element - radons - were mixed with the air in the blast furnace. The moment that the radio-active atoms appeared in the upper section of the blast furnace, a notation was made. As a result, the speed

of the gases was measured very accurately, which fact will be of vital importance in improving blast furnace processes.

Radio-active isotopes can be used to determine the speed at which the stack of refractory material burns down and to determine when repairs are needed on the furnace. In order to do this, small amounts of a radio-active substance are embedded in different strata in the stack of refractory material. Radio-active cobalt, which radiates deeply-penetrating gamma rays, is usually used for this purpose. The radio-activity of smelted pig iron can be determined systematically by using devices which measure radioactive radiation. If the device records an increase in the radioactivity of the pig iron, then this will mean that the stack of refractory material has burned down to the spot where the radioactive preparation is located, which has changed into a smelted metal.

Radioactive substances can be used in industry for examining every kind of casting and for detecting defects in them (blisters, cracks, etc.) X-rays which are used for this purpose can be used to examine only castings which are not very thick. Due to the fact that gamma rays can penetrate very deeply, they can be used to examine an object which is up to 20 cm thick. This method has the advantage that it is not entailing complicated, high-voltage equipment, such as the X-ray equipment.

Strict control over the thickness of the metal is necessary in hot lamination. To maintain this control, a radioactive substance can be placed over the object to be laminated. The radiation from this substance, penetrating clear through the object, will be registered by a devise made especially for this purpose. The greater the thickness of the metal, the more the rays will be absorbed, and the smaller will be the current registered by this device. If the registering device is connected to a mechanism controlling the rollers on the mill, then an increase in the thickness of the object will automatically increase the pressure from the rollers, and a decrease in the thickness of the object will decrease the pressure from the rollers. In this way, the thickness of the rolled iron will be automatically controlled and regulated.

Radioactive isotopes can also be used to study dephosphorization and desulfurization of steel, to study the processes for mixing metal and slag in open-hearth furnaces, and the solution rate of alloy admixtures, etc.

It has been established that, in open-hearth furnaces with a capacity of 350 tons, if a radioactive isotope is introduced into the metallic bath on the bottom of the furnace through the middle charging window, during the decarbonization period it will be uniformly distributed throughout the bath within a period of 10-20 minutes. However, if the isotope is introduced through the end window, its uniform distribution throughout the bath will require 45-50 minutes. Consequently, there is an extremely high distribution rate for small admixtures in the liquid metal during the boiling periof of an open-

hearth furnace bath.

"Tracer" atoms can be used to study kinetic reactions. Studies on the kinetics of the isotope exchange of iron between the metal and the slag, which are in thermodynamic equilibrium, have shown that the slowest process is that of the conversion of the substance being studied in the slag phase, i.e., the diffusion process.

In recent years a method of casting metal without interruption has been introduced in many factories. The molten metal is poured from a ladle into a crystallizer, which has been cooled intensely with water. Complete solidification of the metal does not occur; only a solid crust is formed, the thickness of which depends on the casting speed, the type of steel being melted, the cooling speed, and other factors. The thickness of the crust on the solidified metal and the intensity of the liquid phase at differing casting speeds can be calculated by radioactive isotopes.

Separate protions of radioactive phosphorus were introduced into an ingot a short while after it had been pured. The radioactive isotope was distributed only in the liquid metal. The borderline between the solid and liquid phases was determined by the degree to which the photoemulsion on the automatic radiograph turned black. The introduction of separate portions of the radioactive isotope of iron into the cooling process for steel made it possible to determine very accurately the position of the crystallization front at any time. This was done by utilizing recordings from radiograms of the linear and lateral sections of the ingot.

These studies demonstrated the substantial advantage of casting steel without interruption.

Radioactive isotopes are widely used to solve important, theoretical problems regarding metals and the technology of their production (particularly, for calculating the diffusion, auto-diffusion, metal sublimation constants, etc.)

Radiograph methods are widely used for studying the distribution of elements in ferrous and non-ferrous metals, depending on the type of thermal processing. By using the radio-graphic method, data have been obtained on the structural distribution of molybdenum, phosphorus, carbon, sulfur and chromium in 18KhNMA steel, all of which point to the fact that the indicated elements are concentrated primarily on the module edges.

One of the most important factors determining the reliability and operational economy of steam turbines is the high degree of purity in the steam generated by powerful steam high-pressure boilers. The method of "tracer" atoms was used to study the conversion of substances, which had been dissolved in water, into steam and to study their solubility in steam at laboratories and at industrial installations.

It is extremely difficult, if not impossible, to determine volumetric vapor content by the usual methods. Gamma-radioscopy can be used to study the volumetric vapor content of a steam-water mixture below the "water level".

There is a great future in the field of technological measuring processes for radioactive isotopes, especially in the automatic recording of readings taken by certain devices. For example, barographs which are built on the principle of a metallic barometer-aneroid - are usually used for continuous recording of atmospheric pressure. The most accurate instrument for measuring atmospheric pressure is the mercury barometer; pressure is calculated by the height of the mercury column in the glass tube. However, it is extremely difficult to record automatically the mercury level in the barometer. By using "tracer" atoms it is possible to construct a simple system for recording the readings of the mercury barometer. A steel float, containing a small amount of a radioactive substance radiating beta-rays, can be placed on the surface of the mercury. There is an opening in the lateral face of the float so that the beta-rays can escape. An X-ray film wrapped in black paper is placed around the mercury tube, so that in this way the position of the float and the height of the mercury column are recorded on the film. A time mechanism is employed, and as the film revolves around the mercury tube a continous recording of the barometer reading is made. This type of apparatus can be used, for example, for recording barometer readings on a pilot balloon at more than 10 km altitude.

Radioactive isotopes can also be used to control welding and casting processes. When combined with other technical methods, they will make it possible to accelerate automation of technical processes.

There are many good reasons for the widespread introduction of devices using radio-active isotopes into industry. Already 70 original devices of this type have been developed. Atomic technology insures an almost limitless supply of radioactive isotopes.

Radioactive isotopes are widely used in agriculture also. By using the radioactive isotope of phosphorus, it has been possible to determine exactly which roots feed which branches in the tops of trees and to establish the fact that phosphorus was transferred from the saplings of one species of trees to another through the roots. It has made it possible to study the non-root feeding processes through the assimiliation of phosphorus.

Radioactive isotopes open up tremendous possibilities for studying chemical methods for protecting crops from pests and diseases. The small, even microscopic size of the biological elements being studied, and the extremely complicated biological processes resulting from the toxic effect of insect-fungicides, made it extremely difficult to study them by the usual methods of chemical analysis.

Radioactive phosphorus has made it possible to discover that the reason rodents are killed by baits containing zinc phosphide is that hydrogen phosphide is formed in their stomach and then enters the brain.

Radioactive isotopes are widely used for studying metabolism in biology and in experimental and clinical medicine.

The use of "tracer" glucose has made it possible to determine that the energy exchange in a cancer cell is different from that in normal cells. Since it is well known that a normal cell builds up its albumen primarily due to the oxidizing energy of glucose (respiration), energy from the oxygen-free segmentation of glucose (glycolysis) can be used with great difficulty only under special conditions.

By utilizing "tracer" glucose, it has been possible to determine that albumen is always built up due to the energy of both processes in a cancer cell, where intense respiration is accompanied by intense glycolysis. If these processes are artificially separated, then neither cellular respiration nor oxygen-free glycolysis can guarantee albumen synthesis in a cancer cell.

"Tracer" compounds have also been used successully for calculating rapidly the optimum conditions for biosynthesis of nutrient albumen. They have made it possible to determine the effect of different vitamins and certain amino-acids on the biosynthetic activity of nutrient yeast and to determine what vitamins must be contained in a culture medium for optimum formation of albumen.

Current achievements in the field of atomic energy have opened up wide possibilities for the use of synthetic radioactive isotopes in medicine.

Radioactive cobalt, both in the form of needles and applicators and as the source of radiation in gamma-devices, has found particularly widespread utilization.

Thus, "tracer" atoms can be used in technology, particularly in machine construction, medicine, biology, chemistry, physics, agriculture, etc. More than 30 scientific research organizations and more than 20 metallurgical institutes in the USSR use radioactive isotopes for examining, controlling, and regulating the technological processes in ferrous metallurgy.

The field of "tracer" atoms is expanding daily. In every case, when it is necessary to detect very small amounts of a substance, when great accuracy is required, when results of analysis are desired very rapidly, "tracer" atoms are brought into use.

Protection From Radioactive Radiation.

One of the most important problems resulting from the use of atomic energy is that of developing methods for protecting men and machines from radioactive radiation. Close collaboration between scholars working in the field of nuclear physics, metallurgists, mechanics, and workers in many branches of industry is required in order to solve this problem. The level of science today is such that this problem should be solved successfully very soon. Special protective shields for lowering the dose of radiation from radioactive substances are being used for this purpose. Lead, cast iron, lead glass, concrete, water, etc. are widely used as protective materials.

Protective materials either diminish the intensity of radiation or almost completely absorb it. The degree to which the intensity is weakened depends on the penetrating capacity of the radiation and also on the properties of the protective material.

Individual protection (overalls, robes, gloves, aprons, etc.) is used along with general protective measures in work dealing with radioactive substances.

Special plastic robes, aprons, etc. are worn over cotton clothes in dealing with radioactive substances. This type of protective clothing provides more complete protection from radioactive solutions and dust, acids and alkalis.

For work which must be carried out in contaminated air, special pneumatic costumes made of different plastic materials and special types of anti-dust respirators without vents are used.

In order to protect humans from the harmful effects of radioactive substances, a group of synthetic materials has been developed from which protective clothing, shoes, and respirators are made. The latter item in this suit (LG-2) is made completely of a special plastic material. There are no seams on this suit, which is somewhat like a diver's diving helmet. Its separate sections are joined by high-frequency electric welding, making it completely hermetic.

From above, the respirator looks like a gauze bandage. But since it is made of a plastic material, the outline of the face appears; it is hermetic, convenient, and simple to use. It is also widely used in microbiological institutes and infectious clinics for protection from pathogenic viruses and microbes.

The Atomic Ice Breaker

The use of atomic energy in engines has great potentialities.

The construction of an atomic ice breaker has been a great step forward in the use of atomic energy for transportation in the arctic sea. The turbo-electric atomic ice breaker "Lenin" was completed in Leningrad 25 August 1956 and launched on 5 December 1957.

It will proceed along the North Sea route, breaking up the ice, without having to refuel for two to three years. This ice breaker can serve as a power station and a floating "thermal station". The ice breaker is 134 m long with 16,000 ton displacement. Its three screws have 44,000 h.p. The atomic ice breaker is in operation since 14 September 1959.

Powerful screws combined with a well-designed body enable the ice breaker to pass through ice 2.5 m thick at a speed of two knots.

It can remain afloat without returning to port 10-12 times longer than the ordinary type of ice breaker, and it is 1.5 times more powerful. The daily consumption of nuclear fuel will be calculated in terms of tens of grams; therefore, its range of operation is almost limitless. The great power and good design of the ice breaker make it possible for it to go through thick ice which would be im-

passable for ordinary arctic ships.

The reactor on the atomic ice breaker will consume 200 g of uranium-235 daily, or 70 kg per year. A ship using coal for an engine with the same power would require 2.5 million times more fuel than that with uranium-235. This means that 160,000 tons of coal would be needed for a year's operation, which is ten times greater than the weight of the ship itself.

The construction of a new type of power reactor was a complication in the plans for the ice breaker. It was necessary to have a reactor which, on the one hand, would be comparatively small and, on the other hand, would have sufficient shielding so as not to expose humans to radioactive radiation.

Soviet scholars and engineers have mastered this problem. The heart of the ice breaker is a hydraulic reactor.

There are three powerful atomic reactors on the ship. They can replace each other, so that there is no possibility the ship might run out of power.

The advantages of using atomic energy for transportation lie in the weight requirements of nuclear fuel, which are extremely small. For example, only 2.4 kg of uranium-235 are needed to power an atomic tanker with a load capacity of 25,000 tons from Odessa to Vladivostok (17,400 km), while 3,200 tons of liquid fuel would be needed for a turbine-powered tanker. This means that by using an atomic engine on the tanker, it is possible to increase the load capacity of the vessel by 15-20%. It would only require five trips to transport the same load for which a turbine-powered transport would need six trips.

JET MATERIAL

The theorty of jet propulsion and the mathematical proof for flying in cosmic space with jet engines belong to K. E. Tsiolkovskii. He set forth the theory of reactive motion in the work "Issledovanie Mirovykh Prostranstv Reaktivnymi Priborami" (Study on Outer Space with jet Devices), which was published in 1903. Since this time science has been working on jet engines.

In order to do this, a cosmic ship must overcome the gravitational pull of the earth and fly into the orbit of other planets; upon leaving the atmosphere of the earth, it must have kinetic energy reserves equal to the power it must generate. It is well known that the power required to take anybody beyond the gracitational pull of the earth is equal to the power which is necessary to lift it to a height equal to one radius of the earth.

Any body which attains a speed of 11.2 km per second in a vacuum can escape the gracitational pull of the earth. During its take-off from the earth, a cosmic ship must have a sufficiently high speed to overcome air resistance.

In order to make cosmic flights, it is necessary that the engine is powerful enough to accelerate the ship up to the desired speed and to operate in the space vacuum.

At the present time, only a jet engine can meet these requirements.

Jet Engine.

Jet engines have characteristics which distinguish them from other thermal engines. As is well known, piston engines and turbines transmit the power taken from steam or gas to a shaft, which then turns the intermediate mechanism: the propeller on an airplane, the propeller on a steamer, and the wheels on an automobile. This intermediate mechanism, called the impellent, enables air and sea vessels to move.

A jet engine needs no intermediate mechanism. It does not need auxiliary impellents. The pressure of gas on the chamber walls, without any intermediate mechanism, enables the jet engine to move forward. This characteristic is of great significance, since it causes the efficiency of the engine to increase as the flight speed increases.

It is well known that piston and turbine engines generate constant power to a shaft, independently of the traveling speed of the object in which they are located.

A jet engine maintains a constant pull, and the power which it generates increases proportionately to the speed of motion. Consequently, the faster a rocket aircraft moves, the greater is the power generated by its engine.

Fuel is the source of power in a jet engine. The greater the heat which is liberated by combustion of the fuel in the engine, the greater the kinetic energy from the gas stream emerging from the jet, and the greater the pull of the engine.

Artificial Soviet Earth Satellites.

It was necessary for many complicated, technical problems to be solved before we could build earth satellites. The rocket-carrier, which was used to put the satellite in orbit, presented the greatest difficulties. The rocket-carrier is extremely well designed: it has powerful engines which can operate under difficult thermal conditions, which generate optimum rocket motion, and which provide for its most effective utilization. A very accurate and effective system for automatic rocket control was developed in order to insure that the speed necessary to put the satellite in orbit be maintained.

The solution of these and many other complicated problems are due to the latest technological achievements, and, above all, to the high level of rocket construction in the USSR. The construction of earth satellites in such a short period of time is also due to the high level of our technical potential, particularly to our highly-developed machine construction industry and to our accurate, mathematical computers.

A great amount of experimental work, connected with building and developing both separate units and entire systems in a complex, has gone into the construction of the satellites. The successful development of the satellites has completely confirmed the accuracy of our calculations and of the basic technical decisions which were made in building the rocket-carriers and the satellites.

The First Cosmic Rocket.

On 2 January 1959 the Soviet Union successfully launched a cosmic rocket to the moon. The last stage of the rocket which weighed 1,472 kg (without fuel), brought it close to the moon, and it became the first artificial planet in the solar system.

This represents a new step forward in the conquest of space. A new celestial body, which overcome the gravitational pull of the earth and moves in an elliptical orbit around the sun, was built by the creative labor of the Soviet people.

Rocket flights in cosmic space make it possible to carry out important, scientific experiments on inter-planetary space. It is now possible to make scientific measurements at great distances from the earth.

The launching of a cosmic rocket is a new success of Soviet science and technology. A multi-stage rocket, which is highly efficient and which has powerful, rocket engines, was built to carry out a cosmic flight. A special, automatic system was developed to direct

the cosmic rocket flight on a given trajectory with extreme accuracy. A unique scientific apparatus and special radio telemetering systems were built to make scientific experiments. The scientific and measuring apparatus, along with their power systems, which were placed on board the cosmic rocket weighed 361.3 kg in all. A complex of radio devices, which made it possible to determine the coordinates and the rocket speed every moment, controlled the trajectory of the rocket in cosmic space. Due to their rotation around the sun, the distance between the rocket and the earth will change, now increasing, now decreasing. The greatest distance between them will be 300-350 million kilometers. As the artificial planet and the earth rotate around the sun, they will approach each other to within a distance of about one million kilometers.

The Second Cosmic Rocket.

In accordance with its plan for studying cosmic space, on 12 September 1959 the Soviet Union launched the second cosmic rocket. On 14 September at 0 hours, 02 minutes, 24 seconds, Moscow time, the cosmic rocket reached the surface of the moon. A banner with the insignia of the Soviet Union was dropped on the moon's surface, reading: "Union of Soviet Socialist Republics. September 1959."

The last stage of the cosmic rocket was a controlled rocket which weighed 1,511 kg (without fuel). It carried a container with scientific and radio engineering apparatus. The sphere-shaped container was hermetic and filled with gas. A system for automatic regulation of heat was located in it.

After it was placed in orbit, the container with the scientific telemetering apparatus was separated from the last stage of the rocket.

It is extremely important that the last stage of the cosmic rocket be a controlled rocket. This makes it possible to place it on the trajectory which had been previously calculated and to maintain the necessary speed. It is equipped with excellent apparatus, thereby widening the diapazone of observations.

The average distance from the earth to the moon is 384,386 kilometers. The diameter of the moon is 3,476 kilometers. The lunar surface is 14 times smaller than that of the earth, equalling 37,965,500 cubic kilometers. The volume of the moon is 50 times smaller than that of the earth, equalling 2, 210, 200, 000 cubic kilometers; and its mass is 81 times smaller, its density being 0.6 the density of the earth.

The launching of the second Soviet cosmic rocket strengthened our position as the leader in important fields of science and technology.

The Third Cosmic Rocket.

On 4 October 1959 the third cosmic rocket was successfully launched. An automatic inter-planetary station was placed on board. Launching was carried out by a multi-stage rocket, the last stage of which, upon reaching the desired speed, placed the automatic inter-planetary station in orbit.

The last stage of the third Soviet cosmic rocket weighed 1,553 kg (without fuel).

Scientific and radio engineering apparatus, along with a system for automatic heat regulation, were on board. Electricity for the scientific and radio apparatus was supplied by solar batteries and chemical sources. Total weight of the station was 278.5 kg. In addition to that, there was also a measuring apparatus with a power system weighing 156.5 kg in the last stage. Thus, the total weight of the load was 435 kg.

Pictures of parts of the moon which had never before been seen from the earth were made by the automatic interplanetary station. The photographic process took about 40 minutes. The television pictures were transmitted at cosmic intervals.

The data derived from photographs of the reverse side of the moon made it possible to reach important conclusions regarding its surface.

The launching of an automatic interplanetary station is an unequaled scientific achievement of the Soviet people. The successes of the Soviet Union in the most diverse fields of human activity are without equal. They illustrate the supreme advantage of a socialist system, its enormous achievements in economics, science, and cultural activities. Only socialism can provide a wide scope for the growth of industrial forces, for exploiting the talents of millions of people.

The Soviet people are proud of their successes in science and technology: during the course of just one year, 1959, three cosmic rockets were successfully launched. The launching of the cosmic rockets opens up a new era of interplanetary travel for mankind. But further steps must be taken in studying cosmic space around the sun, planets in the solar system, and flights to other planets.

The time is not distant when interplanetary flights will be made to the farthermost corners of the solar system.

Photon Engine

Rockets with photon engines are being planned, which will attain speeds close to the speed of light. The maximum speed which can be reached theoretically equals the speed of light - 300,000 km/sec. Light quanta, or photons, travel at this speed. At the present time, a photon engine is only a hypothetical possibility. Current technology is not yet capable of developing this, but it can be assumed that in the future photon engines will be used for cosmic flights,

because by using them the aircraft can approach the speed of light.

A speed of 17km/sec is necessary to overcome the pull of solar gravitation. However, the closest star is 4.3 light years away, or 40 trillion kilometers. Even at a speed of 100 km/sec, the flight would take 10,000 years.

How can such a tremendous distance be covered? In order to do this, it is necessary that a rocket move at a speed close to the speed of light (300,000 km/sec). But even at that, atomic rockets, which are presently under construction in several countries, can move at a speed which is still very far from the speed of light. However, the mastering of atomic energy will doubtless play an important role in solving the complex problems of interplanetary flights.

Why can a photon rocket approach the speed of light? Following is a generalized quation by Tsiolkovskii for a photon rocket:

$$\frac{m}{m_o} = \left(\frac{1 - \frac{a}{c}}{1 + \frac{a}{c}} \right)^{\frac{c}{2V}}$$

where m_o is the initial mass; m is the mass at a given moment of time; V is the outflow speed; c is the speed of light, and a is the speed of the rocket at a given moment.

An analysis of this formula shows that the speed of the rockets can approach the speed of light only if the outflow speed is close to the speed of light.

The nature of molecular structure is constantly being penetrated more deeply. Penetrating the nucleus of the atom has opened up the path to the stars. And, regarding interstellar flights, we can cite the words of K. E. Tsiolkovskii to the effect that what is impossible today can become possible tomorrow.

MACHINE BUILDING

The rapid development of machine building, as planned by scheduled figures for development of the USSR national economy between 1959-1965, insures new equipment for industrial installations and improvement in production technology. This is an important factor in the growth of labor productivity and improvement of working conditions.

Particular importance is given in the Seven Year Plan to the electro-technical industry, as the most important technical base for electrification of our country. On the basis of our scientific achievements, it is planned to raise the technical level and the quality of electric machines, installations, apparatus, and electric insulating materials, and to meet the demands for them by all branches of the national economy.

The conversion to complex mechanization and automatically-controlled production by making use of electronics technology is characteristic of current technical progress and must underly the construction of new machines.

The machine building and metal processing industries will almost double during the Seven Year Plan. Industries such as heavy machine building, radio electronics, and electro-technology will be developed at a very rapid rate.

Data regarding the growth of machine construction production and metal processing in our country are seen in Table 12.

Table 12

Production Growth of Machine Building and Metal Working

1913	1928	1957	1958	1965
1.0	1.8	200.0	240	400

Soviet machine building at the present time employs more than 500 different types of steel, pig iron, and alloys of non-ferrous metals. For example, machine builders can produce steel with a yield strength of 200 kg/mm^2. Non-metallic materials - plastics, special types of glass, rubber, etc. - are used along with metals in machine building.

By using strong construction materials, the builder can reduce the size of the components and lower the weight, at the same time increasing the power of the machines and their efficiency.

The development of machine building and other branches of the national economy demands rapid solution of important scientific-technical problems on the part of engineers and manufacturers. First of all they must deal with the dynamic strength and durability of the machine components.

The machines, the separate units, and the components must have great strength and durability. If a machine is not sufficiently strong, it will be necessary to replace the components, units, and individual mechanisms often and will mean inefficient operating costs and additional consumption of metal.

The construction of components, units, and mechanisms must be stronger, and they must be made of highly-resistant metal. If the operational conditions of a given component (temperature, pressure, chemical medium) and the stress which it can undergo are known, it is then possible to select the most suitable type of steel or corresponding alloys.

Effective methods have been developed for strengthening the metallic components by casehardening with high-frequency currents, saturating the surface layer with carbon (cementation), nitrogen (nitration), covering with chromium, etc. To strengthen the surface layer, some components are treated with shots of pig iron or steel. This prolongs the operational time of the separate components and, consequently, of the entire machine. Improvement upon these methods, and the development of new, even more efficient methods, is one of the most important tasks facing machine builders.

During the Seven Year Plan, scheduled figures provide for lowering the unit costs of rolling ferrous metals by not less than 25%.

Preparatory Operations in Machine Building

Forging-pressing equipment, and welding and casting processes are widely used at the present time in all branches of the machine building industry.

In heavy machine building factories recently, a great deal of emphasis has been placed on developing new types of forging-pressing, and welding and casting machines.

The use of progressive technology in the processing of metals under pressure in welding and casting production, thereby providing for increased labor productivity, a minimum consumption of metal, and high-quality production, makes it necessary not only to use new types of machines but also to modernize existing forging-pressing, and welding and casting equipment.

The Seven Year Plan for developing the national economy between 1959-1965 places special emphasis on improving the technology of casting production, drop forging, and on developing precision casting methods in machine building.

Preparatory operations in machine building can be further developed by modernizing existing plants and by constructing 75-80 new plants specializing in casting, forging, and drop forging.

The output of factories specializing in casting equipment will be more than quadrupled. Production of precision casting equipment is planned.

Processing of Metals Under Pressure.

In present-day machine building, the processing of metals under pressure must occupy a leading position - in many branches of machine building, forged and pressed components comprise 60-80% of the total tonnage of steel components. Such a high proportion of components, prepared by methods processing metals under pressure, is due to many reasons: high productivity and efficiency, reduction in metal consumption, great strength and interchangeability of components, etc.

The stock of forging-pressing equipment in the USSR amounts to 410,000 units. Compared to that of 1908, it has increased by 23 times, and compared to 1940 - by 3.5 times.

This development is completely justified, insofar as the quantitative and qualitative make-up of forging-pressing equipment determines the development of progressive forging and drop forging processes.

Practice has shown that the loss of metal in chips, reaching up to 50-70% the weight of the bar, can be considerably reduced by using a drop-forged bar instead of the usual rolled iron. By using a drop-forged bar, 250,000 tons of metal can be saved per each million tons of rolled iron. Thus, 15,000 machines and 30,000 workers are freed.

Current tendencies in the development of drop forging are aimed at gradual replacement of hammer drop forging by powerful drop-forging presses which are cranked. It is also possible to combine the hammer and pressing drop-forging methods with stamping presses, which means a saving in metal of up to 50% due to the production of hollow forged pieces. The conversion from hammer forging to press forging not only increases labor productivity but also provides for considerable savings.

In the USSR powerful crank presses for drop forging are built under a pressure of more than 8,000 tons, and hydraulic presses - under a pressure of more than 30,000 tons. But there is still too high a proportion of hammer forging as opposed to drop-forging presses horizontal forging machines, and other types of press forging equipment.

It is necessary to expand press forging equipment in order to provide the national economy with large-scale forged pieces for building powerful turbines, generators, rolling mills, and other equipment. This is completely possible for us to do.

Casting Production.

The most widely used method for producing shaped bars in present machine construction is casting, which can produce quite complex castings weighing several grams up to hundreds of tons, varying in length from 1 cm up to 30 meters, and varying in thickness from 0.5 - 500 mm.

It can be safely stated that casting production is also a basis for machine building: the proportion of cast components in contemporary machinery ranges from 25% (agricultural machines) to 90% (metal-cutting machines, compressors, etc.).

Pig iron castings predominate among the castings which are produced They make up 50-75% of the weight of different machines. Pig iron castings occupy a particularly prominent position in the construction of metallurgical equipment, machines, and forging-pressing machines.

The machine building industry is the main consumer of shaped bars. A constantly increasing demand for casting prevails in the machine building industry. Greater strength and durability are demanded from cast components, while closer approximation to the final size of the components is required for the cast bars.

The main trends in machine building are directed towards casting technology. These encompass the processing and use of cast alloys of great strength, increased accuracy in the size and purity of the casting surface, and special methods for processing cast items.

The casting industry and its affiliated branches are developing technological processes, materials, and devices which will provide for a constantly increasing quality of castings, maximum utilization of shop space, and normal working conditions in casting factories. During the Seven Year Plan there will be a considerable increase in the production of machines for precision casting under pressure, into ingot molds, into casings, and models which are to be smelted.

Under Soviet rule, the old casting shops have been modernized and equipped with up-to-date machinery. Along with this, a great many new casting shops have been built. All of this has made it possible to greatly increase the output of castings and to increase the quality while lowering the cost.

Our leading casting shops, have successfully carried out the main progressive trends in the technological production of steel, pig iron, and aluminum castings. The task of disseminating their knowledge throughout all of industry confronts the Soviet cast makers. This is the best way to raise the labor productivity in casting shops and to increase the per capita output of castings.

Welding Industry.

Metal welding has developed very extensively in the USSR. A welded object can be built more simply, reliably, and economically

than a riveted object. By using a welding process, it is possible to use a finely-rolled material for very strong construction, thereby making a great saving in metal. In many cases, welding is the only possible process - for example, in the production of chemical apparatus, boilers, and steam pipes with extra large parameters.

When combined with progressive assembly processes, welding can accelerate the industrial process and decrease time and labor. The great advantages of welding cause it to be used in all branches of machine building.

Depending on what type of power is used for tempering, the following types of welding exist: chemical (gas, oxygen), chemical-mechanical (forging and thermite), electro-echmical (atomic-hydrogen), electro-mechanical (arc and electro-slag). Electro-mechanical and electric welding are most widely used in present-day machine building.

In the Soviet Union welding encompasses a great number of ferrous and non-ferrous metals and alloys. Any additional materials or fusing agents which were necessary have been developed, along with power sources for welding machines, transformers, and rectifiers. During the last 10-15 years new progressive methods have been developed for automatic and semi-automatic welding. The Soviet machine building industry produces a great many different welded items - sea-going vessels, railroad cars, high pressure containers, etc.

Our national industries make use of many different types of electrodes, thereby making it possible to construct strong and pliable seams not only with structural steel but also with heat-resistant materials, which are used a great deal at the present time for high-temperature operations.

Automatic welding with flux has been widely developed, as with this method the seam is uniform, compact, and durable. In addition, this method has made it possible to increase productivity and to improve the welders working conditions. Automats and semi-automats operate in many welding shops. Soviet machine building industries are producing many different types of specialized equipment to be used for this progressive process.

A new method of multi-electrode automatic welding is presently being developed - using beading with flux. Under this method, several electrodes which are attached to one power source, are moved in parallel simultaneously into the zone of the arc. The uniform smelting of the electrodes depends on the fact that the ara turn from one electrode to another automatically as a continuous process. The electrodes will be smelted alternately if the heat is dispersed and if, under a high beading coefficient, the metal is not fused very deeply.

In the USSR considerable success has been achieved in the field of arc welding in gas envelopes with non-melting and melting electrodes. Welding in gas envelopes provides great maneuverability and makes it possible to mechanize many operations which would be difficult to do with flux welding. For a long period of time, argon has been used

as the gas envelope. However, its relatively high cost has made it desirable to find a cheaper gas envelope. Recently, a method of steel arc welding under a carbon dioxide envelope has been developed. Welding in carbon dioxide is the cheapest welding method, but it requires the use of low-alloy electrodes.

In recent years, the Electric Welding Institute imeni E. O. Paton and heavy machine building factories have been using a new mthod for welding very thick elements - electro-slag welding. In contrast to arc welding, the source of its heat is that which has been liberated in a liquid slag vat by passing an electric current through it.

With electro-slag welding, it is possible to weld an element from 100-150 mm thick with one electrode. By increasing the number of electrodes in the slag vat, it is possible to weld a metal of almost any thickness.

At the present time, slag welding is being used successfully to combine separate casing elements with a cross section of 400 x 400 mm and more. The forged parts of the casing are combined with forged or rolled elements. This eliminates the necessity of preparing large castings and forgings. Many factories are now using the welding method to prepare presses, rolled mill casings, and large-scale components. Weight of the construction after welding is often 200-300 tons. It is impossible to cast or forge entire constructions weighing this amount in factories. By making use of welding, any average, machine building factory can build components, casings, and boiler collectors which weigh much more than those built by forging or casting methods.

Thus, the use of electro-slag welding has made it possible to replace large, forged machine units with welded-cast, welded-forged, and welded-rolled constructions. This has greatly decreased the load on casting and forging-press shops and has made it possible to increase productive output without extending the productive area. Large-scale casings for forge presses, shafts on powerful, hydraulic turbines, etc., belong to the class of large-scale machine units which can be made with electro-slag welding.

Electro-slag welding has made it possible to construct welded-cast constructions of any dimension from individual, cast elements. Elements of this type of construction can be made by machine molding, thereby reducing the amount of labor required and increasing the precision. Naturally, the mechanical processing of the separate elements is greatly simplified and can be done by ordinary machine tools, not requiring special ones.

Machine Tool Construction

The entire stock of machine tools in pre-revolutionary Russia was about 75,000 (1908), while on 1 January 1957 it was calculated that there were more than 1,840 thousand machine tools in the USSR,

a majority of which were high-quality, modern machines. Thus, during this period, the machine tool stock increased by almost 25 times.

Data on the production growth of metal-cutting machine tools in our country are set forth in Table 13.

Table 13.

Production Growth of Metal-Cutting Machine Tools
(in thousands)

1913	1917	1957	1958	1965
1.5	0.2	130.9	138	190-200

In seven years our industry will be putting out up to a million metal-cutting machine tools. By 1965, the machine tool stock in the USSR will have grown to 2,500 thousand units.

As an example, we can cite certain types of machine tools which will be produced. One of the heavy machine construction plants is producing a boring lathe with a table diameter of 14 m, and weighing about 600 tons. At the present time, construction is being completed on a boring lathe with table diameter of 22 m.

Heavy horizontal-boring machines are being produced to machine large-scale components of reductors, turbines, and other machines. This machine is 6 m high, 10 m long, 8 m wide, and weighs more than 66 tons. Eight electric motors are located on the machine.

Another example of heavy metal-processing equipment is a rotary-milling machine, used for machining generator rotors and metal ahafts, up to 12.5 m long and with a diameter of up to 2.8 meters. The machine is 17 m long and weighs 180 tons; it has 22 electric motors.

A heavy, four-axled, linear-milling machine for machining components weighing up to 120 tons is presently being produced. This machine has components up to 12 m long, and over 3.5 m in heighth and width. The dimensions of the machine are: length - 28.5 m; width - 11.5 m; height - 9 m; weight - 330 tons.

Linear-milling machine, model "6682", for machining components weighing up to 120 tons is currently in production. Its operational table surface is 3,600 x 12,000 m and it weighs 320 tons.

There is also a machine for polishing components which are up to 14 m long and with a diameter of up to 0.5 m. One man can operate it. This machine is 20 m long and weighs 120 tons; it has 35 electric engines.

These examples illustrate the fact that Soviet machine tool construction has made tremendous achievements in the production of

heavy machines. Out of 120 precision machine tools, more than 40 are high-precision machines.

The machine tool industry has been highly successful in producing high-precision machines for use with watch components and other precision mechanisms. The pre-war machine tools have been replaced by new, highly-productive machines which are automatized to a great extent.

As an example, we can cite the new 1K-62 model of a screw-cutting lathe. Due to automation, the operational time has been sharply reduced, and the work of the turner greatly lightened. It is possible to machine components with up to 2,000 revolutions per minute, while on the old 1A-62 model there were 1.2 thousand rpm.

Great tasks confront the Soviet machine tool builder. In a short period of time, the output of highly-productive metal-cutting machine tools and wood-working equipment has increased sharply. In order to meet the demands of the national economy and to accelerate technical progress, it is necessary to develop hundreds of new types of machine tools and machines and to replace old models with the most modern available.

In the factory imeni S. Ordzhonikidz, for example, highly-productive, hydraulic lathe-duplicating semi-automatic machines are being built and put into production. These new machines have many advantages over multi-cutting machines and lathe-duplicating semi-automatic machines which are being produced abroad.

Due to the fact that new semi-automats have been used in the original model, the technology of component manufacturing has been changed; labor productivity has been increased by 3-5 times; and the use of infusible or ceramic cutters has increased the reliability of the operation.

The fact that the machine tools can be easily and rapidly repaired makes it possible for them to be used in small-serial production and to introduce automation in branches of industry which did not previously use automatic or semi-automatic machine tools. In this way the differences between the technology of machine construction on a mass scale and of fine-serial and individual production have been greatly eliminated.

There is possibly another way of solving the problem of automation and mechanization in small-serial and individual production. By combining a considerable number of components with different construction into one group, and manufacturing them according to a special, technological plan, it would be possible to apply large-scale serial production methods to small-serial production.

Full Scale Mechanization and Automation of Industry.

Full scale mechanization and automation of industrial processes is an important way of bringing about further technical progress

in the national economy by raising labor productivity, reducing the cost, and improving production quality.

Work on automation of industrial processes is being carried out in all branches of industry. Our industry has achieved great success in the development of automation, especially in energetics, nonferrous metallurgy, and machine construction. Systems of automatic regulation and remote control have been introduced in the chemical, petroleum-processing, coal, and food industries, to name a few. In many branches of industry and agriculture it is necessary to mechanize the transportation and loading and unloading operations. The main task facing us in the coming years is that of mastering complex mechanization of industrial processes.

At the June (1959) Pelnum of the Central Committee of the GPSU, a report was made on the work of party and Soviet organizations in carrying out the resolution of the XXI Congress of the GPSU to accelerate technical progress in industry and construction work. A resolution was also passed to accelerate the automation and mechanization of industrial processes. The successful realization of the program set forth by the Plenum will mean that Socialist production will rise to an even higher level and that our progress along the path toward Communism will be accelerated.

Scheduled figures for development of the national economy between 1959-1965 set forth the task of changing from automation of separate units and installations to complex automation, to completely-automzied shops, technological processes, and plants.

In the appeal of the June (1959) Plenum of the Central Committee of the GPSU, to workers, to Kolkhoz laborers, to the Soviet intelligentsia, to all workers in the Soviet Union, it was stated: "Our Seven Year Plan is a plan for continuous technical progress in all branches of the national economy, in heavy industry and in light industry, in construction work, in transportation, in agriculture, and for progress in the fields of science and culture ..."

An important element in the field of complex mechanization of industrial processes is that of eliminating heavy hand labor in industry, in construction work, in transportation, and in agriculture.

First of all, it is necessary to carry out complex mechanization and automation of labor-consuming operations and processes in the mining industry, in metallurgy, in the petroleum and chemical industries, in machine construction, in construction work, and in the paper mill industry.

Widespread use of mechanization and automation is necessary in loading and unloading work in all types of load-hauling work and in inter-factory transportation.

In agriculture, full-scale mechanization should be introduced in cultivation of industrial crops, in their harvesting, and in their loading. Also, all labor-consuming processes in livestock breeding should be mechanized.

In all branches of the national economy, special attention must be given to modernizing and replacing outdated equipment to perfecting technological processes, and to industrial specialization and coperativization.

With regard to full scale automation, we must solve the problemlem of converting from automation of separate industrial operations to completely-automized technological processes, shops, and plants, primarily in those branches where automation will bring about maximum economy.

The achievements which have been made in computer technology extend possibilities for the automization of industrial processes. The use of modern computing machines for directing industrial processes makes it possible to select automatically and to carry out a technological operation in the most advantageous way.

Along with fulfilling a general work program for automation in all branches of industry, plan have also been made for building more than 50 experimental plants which will test the newest plans for complex automation.

The basic feature of complex mechanization and automation of industrial process can be carried out with a minimum expenditure of labor on the part of the worker. The worker is primarily responsible for controlling the operation of the machinery.

Extensive application of full scale mechanization and automation of industrial processes opens up tremendous possibilities for an increase in labor productivity, improvement in the production quality, and reduction in production cost.

The construction of atomic installations, rockets, artificial earth satellites, electronic machines, and other contemporary scientific achievements could not be even thought of without the use of different automatic devices and apparatus.

Complex mechanization and automation of industrial processes has become an inseparable part of technical progress in Socialist industry.

Both automation and mechanization have gone through several stages in their development: automation of separation machines and units (machine tools - automats and semi-automats); automation of the operational system of a machine (automized divisions, shops), and complex automation - (construction of factory-automats).

A great many different machine-automats are manufactured in the USSR. For example, a turning lathe which is controlled by a special device has been developed; it is built for automatic multistage turning by a complicated component. One plate is the length of the component, and the other is its diameter. Then, the worker turns the starter, and the machine begins to operate: the cutter is brought up close to the bar automatically, and it cuts precisely the desired thickness and length. Following this, the plate is set for the desired diameter without interruption, and the component is machined further.

When the component is finished, the cutter automatically returns to the initial position. The turner removes the component, places on a new bar, and the machine once again starts up. This machine operates without a flaw. Components are machined to within 0.03 mm. It takes 1.5 - 2 minutes for it to adjust to the change from one metal to another. The turner does not have to be alongside the lathe continuously. At the same time, he can run several automated machines.

But the production of separate machine-automats has not yet completely solved the problems of mechanization and automation, since many auxiliary processes cannot be automized. As a result, the effect of accelerating industrial processes by automatic machines has often been diminished by the loss incurred on auxiliary operations.

This drawback has been eliminated by the creation of auxiliary automatic machines. Practice has shown that their use has increased labor productivity, reduced the amount of necessary equipment, decreased the time for the productive cycle and the so-called auxiliary time, which is necessary for setting up and centering the bar, and has lowered production cost.

Automatic machines producing springs are in operation in automobile factories. Bands of steel are fed by an automat into a machine which cuts them into the desired size. Every three seconds the sheets are passed onto a conveyor which stops and goes. Mechanisms with "spaced edgings" transfer the components of the future spring from one automat to another.

For setting the mechanism into motion, the automatic line is supplied with 175 hydraulic units. The sheets which have been cut go through 32 operations: boring, heating, stamping out of any bulges, tempering, etc. A finished spring emerges from the conveyor every 48 seconds.

This line produces more than two million springs per year. The number of workers necessary to run it is 17 times less than that in a mechanized spring factory.

An automized factory for mass production of bearings was the first to carry out complex automation of all technical processes. Automation of the industry shortened by 10-15 times the cycle of producing the rings and assembling the bearings.

An automat has been built for producing small-displacement engines, which employs power cutting, multi-bar drilling, and many other operations. These operations have made it possible to increase the gross production output.

In many branches of the national economy, mechanization and automation of industrial processes has reached a very high level. The task of mastering complex mechanization of industrial processes stands before USSR industry in the current Seven Year Plan.

Computing Technology.

Our generation is a leader in technological development. In

recent years, the Soviet people have mastered atomic energy and supersonic speeds, attaining a speed of more than 2,000 km per hour. With the launching of the Soviet earth satellites, the attack on cosmic space began.

Man's genius knows no limits in penetrating the secrets of nature, in constantly building newer machines, which lighten, and in some cases replace, men's physical labor.

The necessity of making calculations of enormous scope for solving problems in present-day technology has led to the creation of electronic computers. The extremely rapid work of these computers has forced mathematicians to develop special methods for operating them.

The operation of electronic computers is not limited to one field; it has been found that these machines can also be used for solving various logical problems.

The use of electronic computers can greatly facilitate the solution of such enormous contemporary problems as the calculation of an atomic reactor, of artificial earth satellites, supersonic speeds, and many other problems connected with carrying out tens, or even hundreds, of millions operations in a very brief period, which up to the present time have been impossible.

The correct program must be established and fed into the machine before it can solve any problem. The construction of this program has come to be called programming. Programming consists of working over a system, for solving a given problem, into a form which is suitable for the machine.

A special program is introduced into a machine. It receives this information and reforms it into a working program. But we are still far from being able to consider all programmed answers as decisive.

Thus, it can be said that the machine can carry out only an assignment given to it by a man, expressed in the form of a program which is worked out in detail and then fed into it. The machine cannot operate without this programming and, consequently, is useless without humans. But it also must be said that the machine can carry out an assignment more accurately and faster than a human brain, even if it is confronted with the most complex problems, the solution for which would require a very long period of work on the part of a human being.

Automatic computers are nothing more than organs for carrying out the work of the human mind, for informing mankind about nature, and for providing an economical consumption of man's memory and mental energies.

The development of computers is especially important when our people are entering a period dealing with the construction of a Communist society, one of the basic tasks of which is to free mankind from all heavy labor so he can turn his attention to constructive, creative labor. Computers can free mankind from an enormous amount

of tiresome work which must now be done. On the other hand, an immense sphere of activity, encompassing such problems as controlling different branches of the national economy, industrialization, and planning, is opening up before the computing technology. There is no doubt that in these fields, computing technology can, and must, be of tremendous help to mankind. The guarantee of our future successes lies in this field.

Electronic Computers.

Computers can accelerate and facilitate calculating work by solving differential equations and problems in mathematical physics. Contemporary technology is at a stage of development where each analysis, each new study on complex phenomena, and all engineering calculations require labor-consuming mathematical studies and calculations.

Today the development of computer technology has entered a new phase. Automatic, electronic computers can calculate within an accuracy of millions of a percent, and carry out several thousand operations per second.

The development of automatic machines has led to the replacement of not only physical, but also mental, labor by machines. This branch of technology deals with the use of different calculating and controlling electronic machines.

A modern electronic computer contains thousands of miniature electron tubes; crystalline, electronic amplifiers and rectifiers; electron-ray tubes, and other elements which are necessary for "remembering", i.e., for recording in one form or another the assignments and the results of intermediate calculations. All of these elements are contained in one mechanism.

We have in operation a TsEM-1 electronic computer, which is a normal type of machine. Experimental operation of this machine has shown that its calculations, which would have required the work of three-four technicians and one engineer, are completely correct.

We also have model M-2 computer, whose speed is about 2,000 operations per second, and which contains 1,700 electron tubes. The "Strela" (arrow) model works just about as fast, operating with a speed of 2,000 operations per second and containing 6,000 electron tubes.

Model M-2 occupies 22 cubic meters and can be run by one engineer. It does not have a separate transformer substation nor a graduator. It is 10 times cheaper to manufacture than "Strela", uses 7-8 times less electrical energy, and contains 4 times less electron tubes. This results from extensive use of semi-conducting devices instead of electron tubes.

At the present time model M-3 computer is being built, which is the first small-scale machine. M-3 has 780 tubes and 3,000 semi-conducting devices, and it takes up less than 30-40 cubic meters of space. It is true that the speed of M-3 is considerably less than

that of M-2; 30 operations per second. But over a 8-hour period it can complete the work which it would take 200 engineers to do, using modern electric comptometers.

Model M-3 is to be used in scientific research institutes, and provides a very good experimental basis for work on specialized machines controlling industrial processes. M-3 is being built in the shape of three separate cabinets connected to each other by hoses. Therefore, it can be placed in any position.

Great attention has been given to the small-scale model MN-M which operates continuously. By using it, different systems of automatic regulation can be studied and complex problems in mathematical physics can be solved extremely rapidly.

The electronic computer "Ural" is also under construction. It has 800 tubes, 3,000 germanic diodes, and uses 8 KW of electric energy. The machine takes up about 40 cubic meters, and operates with a speed of 100 operations per second. It contains a magnetic drum with 1,024 cubicles and a magnetic band with up to 40,000 cubicles. The calculation results are fed onto the paper band at a rate of 100,000 symbols per minute.

In addition to that, Soviet computer model BESM is now in operation, with a speed of 8 - 10,000 operations per second. It can make a complex calculation in three millionths of a second. The machine operates 24 hours a day. It has 5,000 electron tubes which will last more than 10,000 hours. It takes up about 150 cubic meters of space and uses up to 100 kilowatt.

The BESM computer has calculated the orbits of about 700 small planets in the solar system and the influence of Jupiter and Saturn upon them. Their coordinates have been calculated for the next 10 years, along with their location every 40 days.

Previously, these calculations would have required many months' labor by a large, calculating department.

Instead of tens of years, model BESM was able to set up in one hour a table of integrals which encompassed 50,000 values. It calculated a table for determining the maximum slant of canals, which lead to a great saving of materials in hydro-technical construction.

At the present time, a new, rapid electronic computer, BESM-2, is on the drawing boards. It is a modernized form of model BESM, designed for series output, more efficient operation, and apparently has an operative "memory" which is twice that of the BESM model. It can accommodate 2,046 numbers, and it will take one ten-millionth of a second to record and select a number.

The upper "memory" of BESM-2 is made up of two magnetic drums and eight magnetophones with bands. The capacity of the drums is 10,240 numbers. Up to 800 numbers per second can be recorded on each of the drums. The volume of the magnetic bands is about 120,000 numbers.

There is no need to state that this branch of industry is rapidly developing. For example, a computer which can make 30,000

logical solutions per second, 8,400 additions or 1,200 multiplications, is presently being planned. It will "remember" eight million facts dealing with more than 150,000 objects and apparatus. Every day the computer will be able to introduce 37,500 changes in the facts and calculate these changes.

The construction of computers operating at a speed of 100,000, and even up to one million, operations per second is a real possibility. And it goes without saying that such computers will be built. Right now, for example, a computer has already been built with a tremendously rapid "memory". These machines are to be used for rapid automatic checking and analysis of scientific-technical literature which has been collected by mankind over many years in many fields of learning.

The development of science calls for the creation of rapid-operation, machine technology for processing the worldwide fund of scientific literature. The solution of this problem by information machines makes it possible to utilize the enormous potential riches accumulated by man's genius in literature, and in this way to increase the productivity of mental labor.

A long-lasting, rapidly-operating, "memory" machine has been built to record and to store up data. This "memory" has no mechanical, movable parts, and, therefore, it can reproduce written material in the form of electric signals over a long period of time (ten years) and at a very great speed (millions of "pages" per hour).

Further technical development in the construction of electronic controlling machines depends to a considerable degree upon high-quality semi-conductors, magnetic radio agents, the technical components, and also upon scientific studies in the field of physics and chemistry.

In the very near future we can expect small (compact, comptometer-like) electronic computers to be put into use. They will be widely used in all branches of our industry, in scientific research institutes, in industrial laboratories, and institutions of higher learning.

Already a new electronic computer, model SESM, is under construction. Many electron tubes and ferrite and semi-conductor elements are used in it. It takes up eight cubic meters of space. In addition to that, it is simple to run. In one shift this machine will be able to do the work it would take 20 men one month to do, using ordinary comptometers.

Model SESM is the first numerical machine in our country and in Europe which makes calculations with linear algebraic equations containing a great number of unknowns - up to 400. It can solve complex problems on the construction of hydrotechnical installations and in mathematical physics. This machine has already solved many practical problems and has made interesting mathematical studies.

We have had a great deal of success in the construction and production of electronic computers. Thus, we are fully justified in

expecting in the near future new achievements in the technology of electronic machine construction.

Programmed Control of Metal-Cutting Machine Tools.

Automation of industrial processes is one of the main trends in technical progress in our country.

Automation is widely used in machine building, especially in mass production. For example, in automobile, tractor, and other factories employing mass production, the majority of the machines operate on an automatic or semi-automatic cycle.

However, in the machine tool construction industry, serial and small-serial production exists along with mass production.

In recent years a great deal of attention has been given to programmed control of industrial processes. Programmed control of metal-cutting machine tools, which utilize electronic computers, has many advantages over other automation methods. It opens up the possibility of introducing widespread automation into small-serial, and even individual, production.

In mass production, programmed control makes the technological process more flexible, and makes it possible to introduce changes, both in the technological process and in construction of the units, relatively easily.

With programmed control, efficiency of the equipment is increased and idle time is reduced. Computers, which are an integral part of a programmed control system, can increase the precision and speed of producing complex designs.

The flexibility of programmed control makes it possible to make changes in the production process, and the builder is freed from dealing primarily with straight lines and circles and can build components with ideal technical properties.

The cost of programmed control units is from 20 - 40% that of the machine, while producitivity is greatly increased.

A programming unit was installed on screw-cutting lathe 16-1A, while longitudinal and lateral power for the support came from separate electric engines. Precision was 0.25 mm for the diameter and 0.2 mm for the length.

Machine-tool builders have carried out a great deal of work in this field. Several programming methods, among them recording on magnetic tape and drums, have been developed for construction of pitch engines, and experimental machine tools have been built. A milling machine with programmed control was developed. Flat cams and similar components can be machined on it. The program is recorded on tape and is assigned to the radial movement of the cutter. But the inconstancy of the worker in making the shape and the limited use of such machines keeps them from competing with modern hydro-copying machines, on which any design can be shaped uniformly.

In principle, a computer can be set up outside of the factory, and it can control the operation of several machines at once. However, these machines are still in the experimental stage, although there is no doubt that in the future they will find wide use in overall, complex automation of industry.

Due to the use of new systems of programmed control, which have been developed as a result of recent achievements in computing technology, all demands which are made on automized machines in serial production can be met. Programmed control makes it possible to solve one important technical problem: that of producing components with complex, curved surfaces with a minimum expenditure of materials and time.

Programmed control of metal-cutting machine tools with electronic computers is one method which can create a real basis for complete automation of production. Its greatest advantage is the possibility of flexible automation, which would make it possible to shift very rapidly from the production of one item to the production of others.

In recent years within the Soviet Union, there has been widespread introduction of programmed control computers for controlling not only individual machines but a lso entire production lines, rolling mills, etc.

In order to further develop this type of automation, program control units should be installed on machines for producing components with complex designs and which require great precision (stamps, turbine vanes, airplane components, cams, etc.).

OTHER BRANCHES OF INDUSTRY

Chemical Industry.

Scheduled figures for development of the national economy for 1959-1965 stipulate development of the chemical industry. The total volume of chemical production has increased by approximately three times. The production of synthetic materials must be widely developed.

The party and the government place great significance on development of the chemical industry. The May 1958 Plenum of the Central Committee of the CPSU set forth a resolution to accelerate development of the chemical industry. The June 1959 Plenum of the Central Committee of the CPSU set forth new tasks for accelerated development of the chemical industry, the successful accomplishment of which will contribute to further progress in this important branch of the national economy.

A new raw material base must be established for the production of polymer materials. Present plans call for widespread development of the synthetic material industry by using gases from petroleum extraction and natural gases.

During the Seven Year Plan, it is planned that the output of mineral fertilizers will triple. The production of concentrated mineral fertilizers, which are the most effective phosphoro-organic preparations for combating pests and diseases among crops, and of chemical agents for combating weeds, will increase.

In the coming years, the production of highly-concentrated fertilizers, containing two or three times more nutritive elements than superphosphate, will also be developed.

The production of chemical agents for protecting crops from harmful insects, diseases, and dust will increase along with the production of fertilizers.

During the Seven Year Plan, more than 140 large-scale chemical plants must be built and more than 130 plants must be modernized. Plans call for building enormous, combination plants with complex reprocessing of gases from petroleum extraction, natural gases, gases resulting from the extraction of gases, and other types of raw material.

There are tremendous possibilities for the use of plastics in many branches of industry. Thus, the body of a small automobile, made out of plastic, uses half the amount of metal, simplifies the technical diagram for its production, decreases the number of components, while its durability is increased.

The use of plastics makes it possible to economize on non-ferrous metals: 1 ton of electrical insulation made of poly-vinyl chloride, saves five tons of lead; 1 ton of a new type of synthetic resin can replace four tons of copper, etc. The use of synthetic resins in the production of precision castings decreases the metal consumption by 15-20% and the consumption of molding materials by 7-8 times, while it increases labor productivity by 30%.

The value of synthetic materials can readily be seen from the example of cloth production. From one cubic meter of wood pulp, for example, it is possible to produce 200 kg of cellulose, from which 180 kg of silk thread can be obtained. This is a sufficient amount to manufacture 4,000 pairs of stockings or the fabric for 600 suits.

The production technology for raw hide includes mechanical and chemical processes. The role of chemical processes, beginning with preservation of the raw hide and ending with the finishing of the leather, is extremely important. Tanning and dyeing of hides are typical chemical processes. The tanning process uses a wide group of tanning substances from plants, and synthetic tanning substances such as sulfurized phenol. The production of cheap synthetic tanning substances has increased a great deal recently.

Achievements in the production of rubber, plastic, and other new materials have made it possible to modify considerably the raw material base of the leather shoe industry. The use of leather substitutes increases constantly in shoe production. A new type of artificial leather has been developed, which is made of cotton fibers,

paste-like resins, synthetic rubber, and caprolactome. It is cheaper than natural leather, and the quality of items made from it is not inferior to those made from natural leather. A task which must be fulfilled in the near future is that of completing replacing leather which is used for technical purposes.

The chemical industry produces considerable amounts of chemical reagents, dyes, and new drugs (among them drugs for tuberculosis, malaria, pneumonia).

The development of atomic technology, and the construction of modern jet planes and rockets would not be possible without new synthetic materials, which are stable at low and high temperatures. Atomic technology is connected with the industrial production of a large group of rate metals and alloys. Germanium and silicon are the main materials for semi-conductor technology. At the present time, new branches of industrial production are being created, which will process metals which are very valuable for modern technology, among them titanium, germanium, zirconium, and others.

Ferrous Metallurgy.

Scheduled figures for development of the national economy for 1959-1965 provide for an accelerated development of ferrous metallurgy, especially its iron or base.

Plans call for opening up new iron ore depots, employing open pit mining, and for the construction of powerful mining combines in order to develop the iron ore base of ferrous metallurgy. In order to increase the productivity of blast furnaces, it is planned to increase the iron content in marketable ores.

Between 1959-1965 new production capacities will be exploited, in the smelting of 24-20 million tons of pig iron, in contrast to 16.3 million tons between 1952-1958; in the smelting of 28-26 million tons of steel, in contrast to 12.4 million tons; and in the production of 23-29 million tons of rolled iron, in contrast to 6.9 million tons previously.

The level of ferrous metallurgy has risen considerably in the USSR. Between 1959-1965 powerful mechanized and automized metallurgical installations will be built, based on the most recent technology. Plans call for building highly-productive rolling mills and finishing mills, which will provide for a continuous production process and for quality control, along with complex mechanization and automation of the industrial operations. Complex mechanization and automation of coal-tar chemical, refractory material, and ferroalloy production will be widespread. New, highly-effective technological processes will be widely introduced during the Seven Year Plan.

Data on the increase in pig iron, steel, and rolled iron production seen in Table 14.

Table 14.

Production Growth of Pig Iron, Steel, and Rolled Iron
(in million tons)

	1913	1917	1957	1958	1965
Pig Iron	4.2	3.0	37.0	39.6	65-70
Steel	4.31	3.1	51.2	54.9	86-91
Rolled Iron	3.59	2.0	40.2	42.9	65-70

Automation is employed in blast furnace and open-hearth furnace industries, while production processes such as loading, regulating the blast, etc., are also automized. The use of automatic devices on open-hearth furnaces provides a great saving in fuel, and increases their productivity. More attention is being given to the use of oxygen in metallurgy.

At the present time, Soviet metallurgists are working on continuous production of a metal. In the production of steel, an operation such as casting the metal takes place periodically between 8-10 hours. The problem to be solved consists of making this a continuous production process, and its solution will be of great importance to the national economy.

Production of Consumer Goods and Foodstuffs.

Light industry, the food industry, and production of consumer goods are all constantly growing due to the high level of heavy industry and to the successful fulfillment of plans set forth by the party to improve agriculture in our country.

At the present time in the USSR, all the necessary conditions are present for increasing the output of industrial items, foodstuffs, and consumer goods, and when this is accomplished we shall have come a long way towards satisfying the constantly growing material and cultural demands of the Soviet people.

During the Seven Year Plan, the consumer good industry will be based on a new technology. Automation and mechanization of industrial processes will be widely introduced, which will raise even higher the technical level of consumer good production.

By the end of the Seven Year Plan, the Soviet Union will have approached the level of the United States in the production of cloth, clothing, and shoes, both in over all production volume and in per capita production.

A great many new consumer good industries will be built, and production in existing industries will be constantly improved during the Seven Year Plan.

Controlled figures for development of the national economy for 1959-1965 indicate that in per capita foodstuff production, the USSR will overtake and surpass the most highly developed capitalist countries.

About 250 new meat-processing plants, more than 1,000 dairies, and more than 200 canneries will be put into operation during these seven years. The capacity of sugar factories, which process sugar beets, will increase by 3.2 million centners per day, or in other words it will more than double.

In plants which are already in existence, it is planned to increase production output by more complete utilization of productive capacities, by the introduction of new technological processes of mechanization and automation, by providing for complex raw material utilization, by increasing the output of pre-fabricated production, and by reducing the amount of loss and waste in production. The cubic content of refrigerators for storing perishable goods will be more than doubled.

Taking into account the fact that a considerable portion of agricultural material is processed outside of state foodstuff plants, it will be necessary to build plants for baking bread, for processing meat, butter, cheese, curds, fruit and vegetables, and other food products, utilizing the energies of kolkhoz workers, sovkhoz workers, and consumers. Along with the construction of plants for processing agricultural items in the individual kolkhoz, it would be a good idea for several kolkhozes to bad together in building inter-kolkhoz food-processing plants. This would make it possible to build larger plants using modern technology and technological production.

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In our country there has been widespread development of atomic and reactive technology, radar and television, electronic technology, chemical technology, and so on. Our progress knows no limits. Any new technological achievement is a starting point for further technical progress. This is why behind our technology today there already looms the clearly defined outline of even more grandiose technical achievements.

The industrial forces of the Soviet Union have unlimited possibilities for their prosperity, and our industry can be developed at a very rapid tempo, which will make the growth of capitalist industry look pale, even in the years of their most rapid growth. Data on the development of Soviet economy in the current Seven Year Plan attest to this fact.

The main task of the Seven Year Plan consists of further developing all branches of the economy by the pre-eminent growth of heavy industry and by strengthening of the economic potential of the country.

On this basis, there will be a significant rise in the standard of living in our country.

Soviet technology is not set apart from the life of Socialist society, it is not divorced from practice; rather, it is closely bound to it and illuminates the way toward further development.

We look back with pride on the path travelled by the Soviet Union. The Soviet people are filled with determination to devote all their knowledge and their capabilities to the greatide of communism, to the idea of peace throughout the world.

The prospects for our further achievements are great and clearly defined. The efforts of the Soviet people will be strengthened in the future; they will be concentrated upon the grandiose task of building communism.

The Soviet people are moving along the path of technical progress ever more rapidly. Lenin's testament regarding the development of industry, technology, and science has found its highest expression in the historic resolutions of the XXI Congress of the CPSU. The accomplishment of the great program for technical progress, which was set forth at the XXI Congress of the CPSU and by the June (1959) Plenum of the Central Committee of the CPSU, will make it possible to take a tremendous step forward along the path toward a powerful, new rise in the economy of our country, and along the path leading us to communism.

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